FINAL

CORRIDOR SYSTEM MANAGEMENT PLAN (CSMP)
LOS ANGELES COUNTY I-405 CORRIDOR
COMPREHENSIVE PERFORMANCE ASSESSMENT

May 28, 2008

System Metrics Group, Inc.

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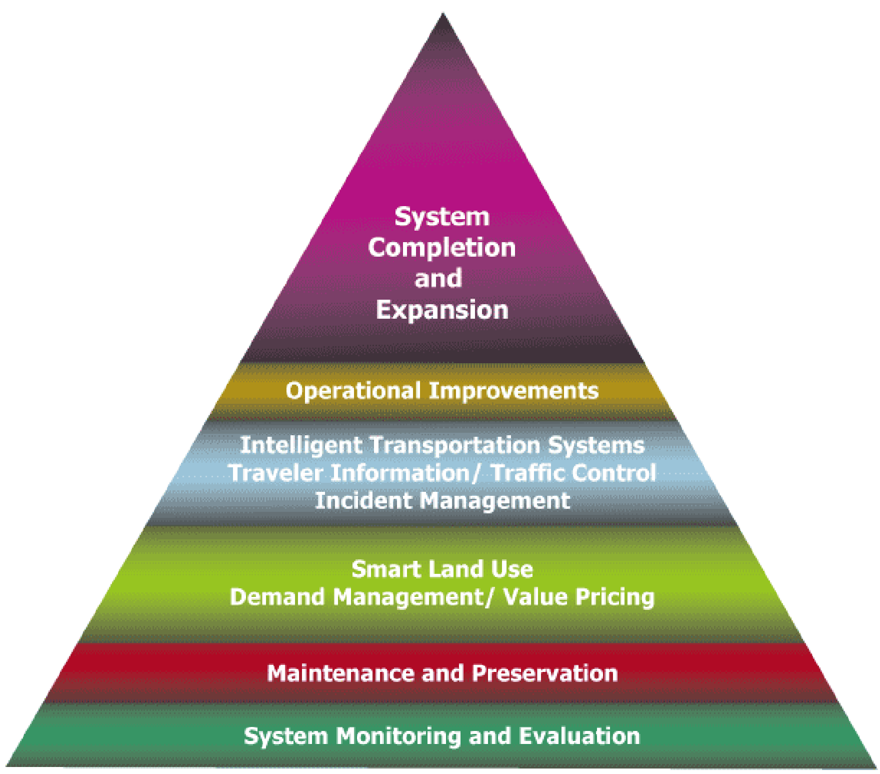
1. INTRODUCTION

This report represents the draft Corridor Comprehensive Performance Assessment Report for the I-405 corridor in Los Angeles County. Once finalized, it will be a critical component of the Corridor System Management Plan (CSMP) required by the California Transportation Commission as part of the Corridor Mobility Improvement Account (CMIA) approved by the voters in California in 2006. This account will partly fund the construction of the northbound High Occupancy Vehicle (HOV) lane from the I-10 to the US-101.

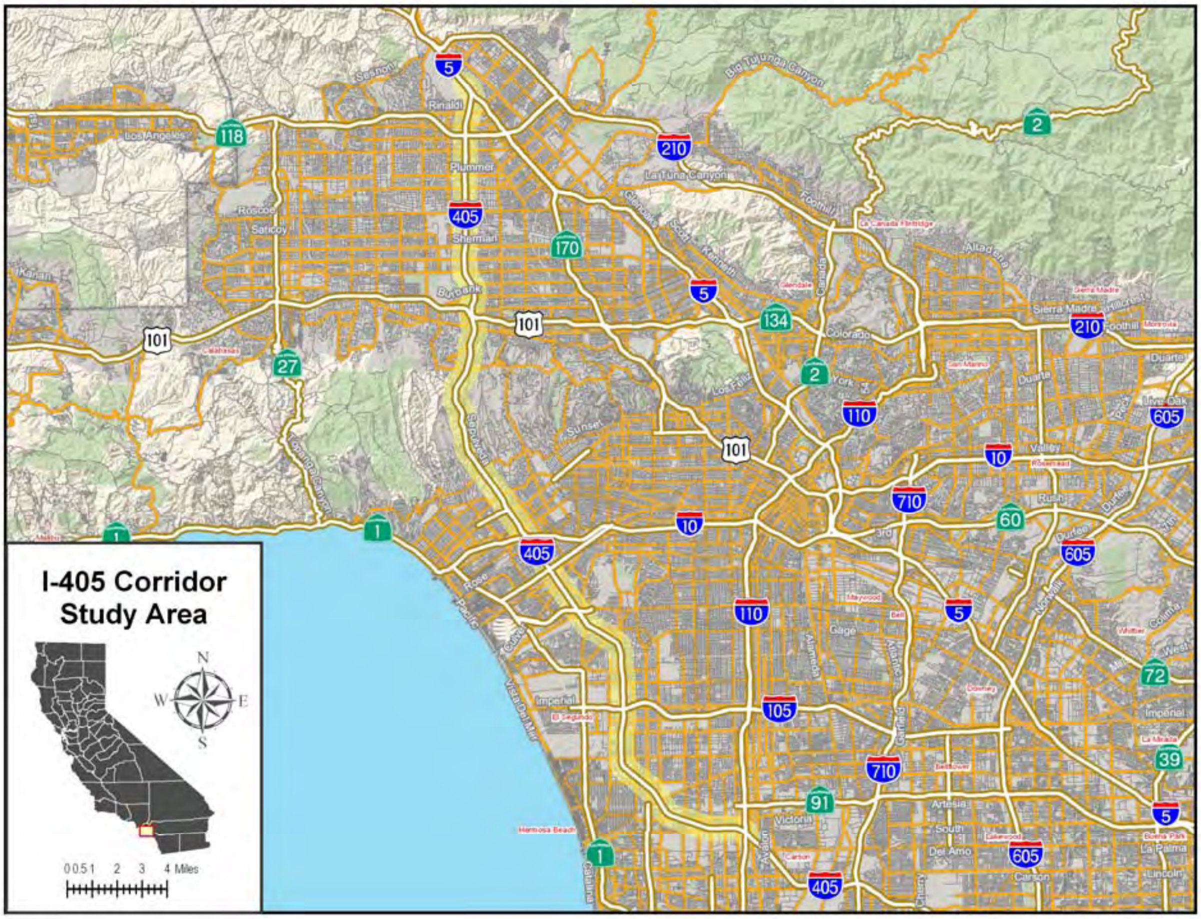
Although this report addresses the CTC requirement, it also represents a commitment by the Department of Transportation (Caltrans), the Southern California Association of Governments (SCAG), and the Los Angeles County Metropolitan Transportation Authority (Metro) to system management as depicted in Exhibit 1-1. System management aims to get the most of our transportation infrastructure through a variety of strategies, not just through the traditional and increasingly expensive expansion projects. Moreover, it relies on extensive and continuous system monitoring and evaluation as the foundation of identifying problems, evaluating solutions (and combinations thereof), and eventually funding the most promising strategies. This report represents the version of this foundation and should be updated on a regular basis as conditions on the corridor evolve.

Exhibit 1-1: System Management Pyramid



The corridor extends from the I-110 junction to the I-5 junction – a distance of approximately 36 miles. It is highlighted in Exhibit 1-2.

Exhibit 1-2: Map of Study Area



The purpose of the corridor-wide performance assessment is to collect and analyze all information necessary to understand the existing traffic conditions. This report details findings of the causes of traffic congestion along the corridor and identifies freeway bottlenecks and the likely causes for the bottlenecks. Ideally, the freeway assessment component of this report would rely on comprehensive and continuous data collected over the years from automatic freeway detection systems (generally inductive loops located below the pavement, radar, or other electronic devices) and other field data collected for special studies or annual reports. Unfortunately that was not possible for the study corridor for a variety of reasons, including:

- Corridor construction – Caltrans often has to disconnect detectors during construction activities. The study corridor has been under some degree of construction for almost eight years. Construction included the southbound HOV lane from the US-101 to the I-10, HOV lanes in both directions from the I-105 to SR-90, and current project extending the HOV lane from SR-90 to the I-10 in both directions. As a result, detection data is sporadic and reflects the impacts of the construction activities.

- Detector reliability – Over the years, detection systems fail. When funding is scarce and needs are high, it is usually impossible to keep all detectors in good working conditions. As a result, the data used in this report has many “holes”.

- Available data collected in the field using probe vehicles that record speeds during peak commute periods were very useful and complemented the detection data. However, they represented a very small sample of traffic conditions throughout the years.

- Field observations conducted by the study team to evaluate bottlenecks occurred primarily in 2007 and early 2008, which represent more recent data and likely reflect different traffic conditions than detection and probe data analyzed.

As a result, four sets of different data were used: (1) detection data from 2001 through 2003, (2) Highway Congestion Monitoring data from 2004 through 2006, (3) probe vehicle data from 2002/2003, and field observations from 2007/2008. *<u>Although the study team believes that the conclusions of these reports are reasonably accurate and defensible, it believes it is prudent to keep updating the findings and conclusions on a regular basis once more consistent data is available and current construction is completed.</u>*

The report describes current transit services and to some extent the local arterial network. However, due to budget and schedule constraints, the assessment findings focus solely on freeway corridor and traffic operations in terms of performance assessment and bottleneck identification. Planned improvements to transit and arterials will be indirectly incorporated into the CSMP document to the extent that regional model data reflect them.

Also note that the performance measures used in this report are consistent with the adopted measurement framework at SCAG and at Caltrans and include: mobility, reliability, safety, and productivity.

The remainder of this report is organized as follows:

1. Corridor Description –corridor roadway and other transportation infrastructure including:

- General description and geometry;

- Transit network including Metrolink commuter service, Los Angeles County Metropolitan Transportation Authority (Metro) bus and rail service, Antelope Valley Transit, Santa Clarita Transit, and the Santa Monica Big Blue Bus;
- LAX Airport; and
- Adjacent sites and facilities relevant to the corridor.

2. Existing Conditions – preliminary assessment of all currently available traffic performance data for initial evaluation of the existing traffic conditions, focusing on four key travel performance measures:

- *Mobility* - describes how well the corridor moves people and freight;
- *Reliability* - captures the relative predictability of the public's travel time;
- *Safety* - captures the safety characteristics such as collisions; and
- *Productivity* – describes the productivity loss due to inefficiencies in the corridor.

3. Bottleneck Analysis – identification of existing recurrent traffic congestion in the corridor. Freeway bottleneck locations that create mobility constraints are identified and documented.

4. Bottleneck Causality – identification of the causes of the bottlenecks based on field inspection and engineering assessment.

Existing Data Sources

The existing available data analyzed for the existing conditions performance assessment includes the following sources:

- Caltrans HICOMP report and data files (2004 – 2006)
- Caltrans Freeway Performance Measurement System (PeMS)
- Caltrans District 7 probe vehicle runs (electronic tach runs)
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS)
- Traffic study reports (various)
- Aerial photographs (Google Earth) and Caltrans photologs
- Internet (e.g., Metro website, Metrolink website)

Details of each data source used are provided in their applicable sections of this report.

2. CORRIDOR DESCRIPTION

The Los Angeles County I-405 corridor begins from the I-110 (Harbor Freeway) interchange in Torrance (post mile 12.5) to the end of the freeway at the I-5 (Golden State Freeway) interchange in San Fernando (post mile 48.5). It extends approximately 36 miles and traverses through the cities in the South Bay such as Torrance, Carson, Lawndale, Hawthorne, and Inglewood. It also traverses through the cities of Santa Monica and Culver City, ending in San Fernando and Van Nuys.

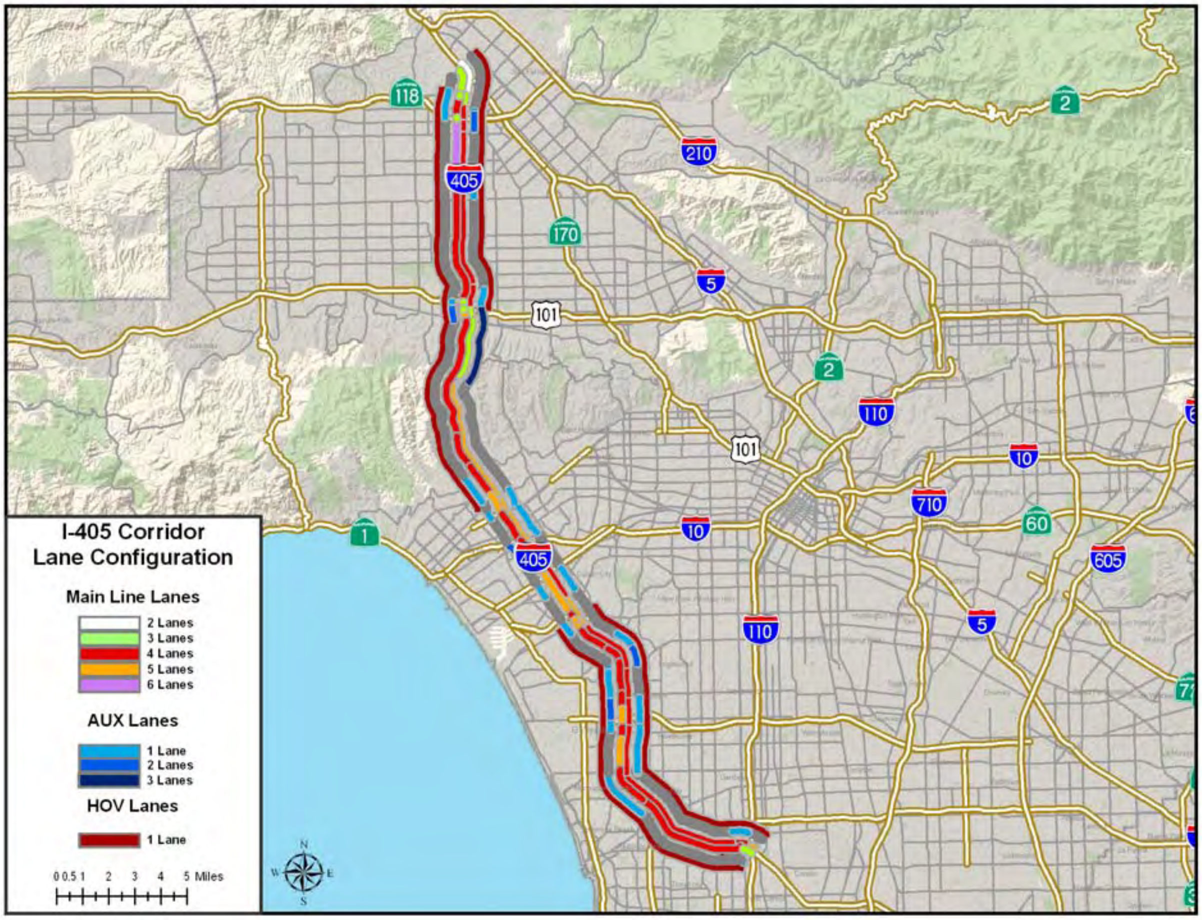
Corridor Roadway Facility

The study corridor traverses a large portion of the northern section of Los Angeles County and connects several of the major communities. The corridor includes 36 miles of I-405 from its beginning at the I-110 junction to I-5. It intersects many of the key east-west corridors in Los Angeles County. The major interchanges in the I-405 study corridor include the following:

- I-110, which provides north-south access from Pasadena to San Pedro.
- Artesia Boulevard (SR-91), which provides east-west access from Riverside County to coastal cities such as Manhattan Beach and Hermosa Beach.
- Rosecrans Avenue, which provides east-west access from La Mirada on the east to El Segundo on the west.
- I-105 (Glenn Anderson Freeway), which provides east-west access from the I-605 interchange to the Los Angeles International Airport (LAX).
- SR-90 (Marina Freeway), which provides access to Marina Del Rey and Playa Vista.
- I-10 (Santa Monica Freeway), which provides east-west access from San Bernardino County to Culver City and Santa Monica.
- US-101 (Ventura Freeway), which provides interregional access from downtown Los Angeles to northern California.
- SR-118 (Ronald Reagan Freeway), which provides east-west access from the I-405 freeway/San Fernando to Ventura County.

HOV lanes are available throughout the majority of the corridor except for both directions from the SR-90 (Marina Freeway) to the I-10 (Santa Monica Freeway) and in the northbound direction from the I-10 to the US-101. Ramp meters are active during both the morning and afternoon peak periods. Directions of travel are divided by a concrete median. Exhibit 2-2 shows the lane configurations along the I-405 corridor.

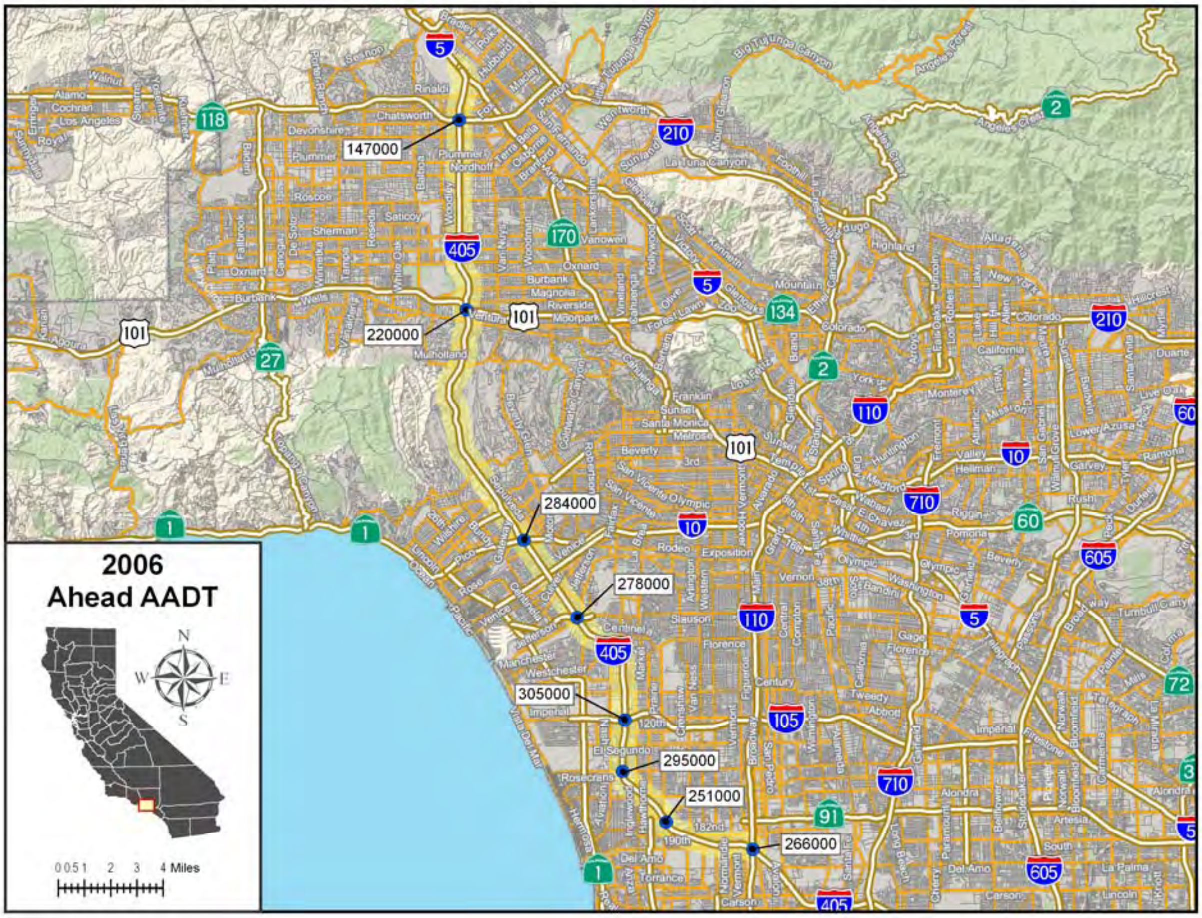
Exhibit 2-1: I-405 Corridor Lane Configuration



The 2006 Caltrans Traffic and Volume Data Systems indicate that the annual average daily traffic (AADT) ranges from 140,000 to 305,000 vehicles per day, as illustrated in Exhibit 2-2. The highest AADT was reported at or around the 405/105 interchange.

I-405 is also a part of the STAA National Truck Network. According to the 2005 Annual Average Daily Truck Traffic on the California State Highway System published by Caltrans in November 2006, this corridor's daily truck traffic ranges from 3.6 percent to 5.4 percent of the total daily traffic.

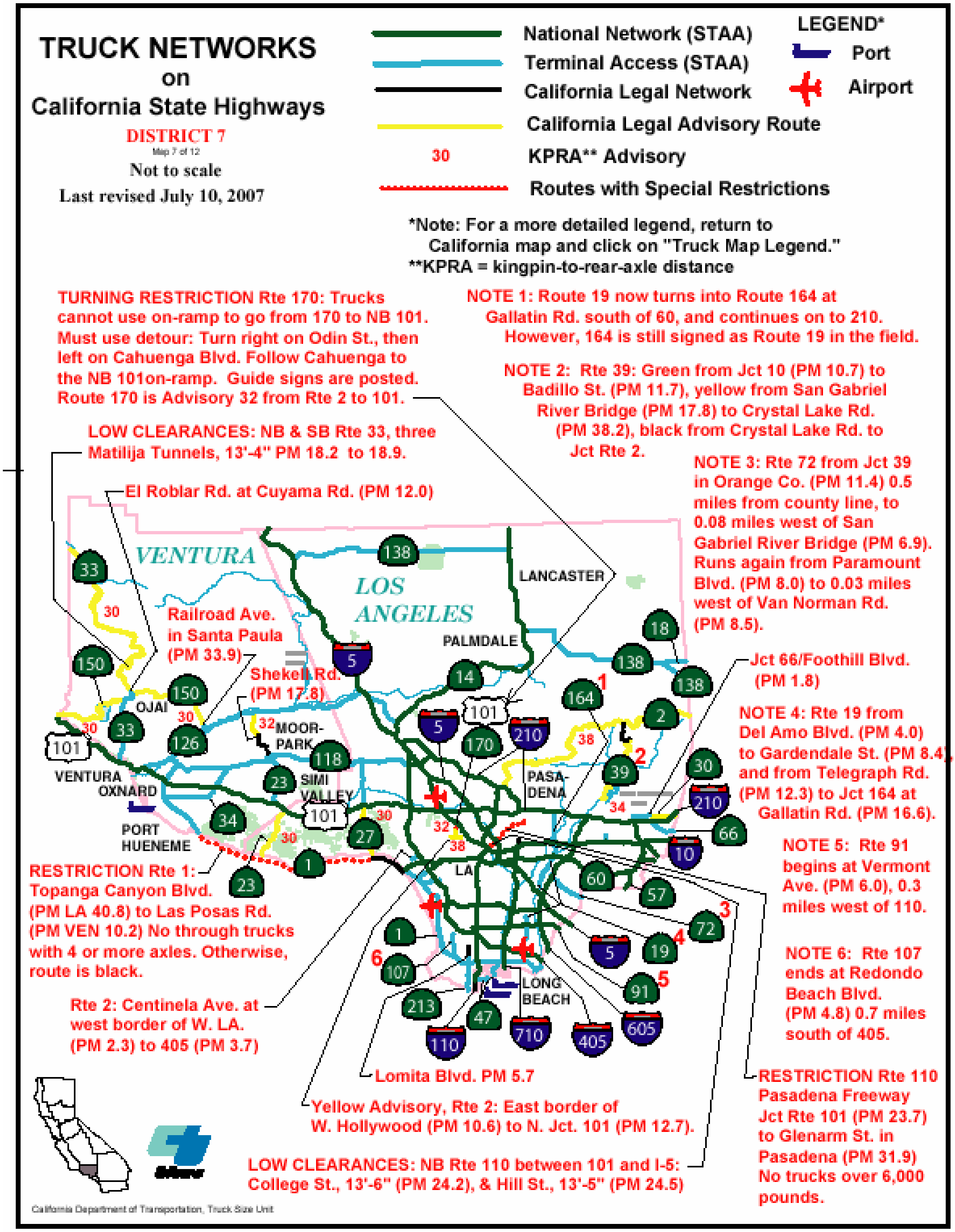
Exhibit 2-2: Major Interchanges and AADT along the I-405 Corridor



Source: AADT is from the Caltrans Traffic and Vehicle Data Systems Unit[1]

[1] http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/

Exhibit 2-3: Los Angeles & Ventura County Truck Networks



Recent and Planned Roadway Improvements

Several roadway improvements have recently been completed and others are currently under construction along the corridor:

- HOV lanes in both directions from I-105 to SR-90 were recently constructed and opened to traffic in 2004
- HOV lane extensions from SR-90 to I-10 in both directions are currently under construction and are scheduled to be completed in late 2008/early 2009.
- A southbound only HOV lane extension from Sunset Boulevard to I-10 is also under construction and is also scheduled to be completed in late 2008/early 2009.
- Construction on a northbound HOV lane from I-10 to US-101 (partly funded by CMIA) is scheduled to begin in spring 2009.

In all, HOV related construction has been under way on the study corridor since 2000. Once all these activities are concluded, a new fresh look at corridor performance and problems will be needed to take into consideration likely shifting traffic patterns.

Transit

Major transit operators within the I-405 study corridor include Los Angeles County Metropolitan Transportation Authority (Metro), Metrolink commuter rail service, Antelope Valley Transit, Santa Clarita Transit, Culver City Transit, Los Angeles City Department of Transportation Commuter Express, and Santa Monica's Big Blue Bus.

Metro operates local bus, rapid bus, and rail service along or parallel to the I-405 corridor. In the northerly portion of the corridor from the I-5 to the I-101, Metro operates Line 234, which runs southern along Sepulveda Boulevard from the Sylmar/San Fernando Metrolink Station southbound. Lines 233 and 237 run parallel to the study corridor along Van Nuys Boulevard.

In addition to these bus lines, Metro also operates Metro Rapid 734 along Sepulveda Boulevard and Metro Rapid 761 along Van Nuys Boulevard. Metro Orange Line crosses the study corridor south of Victory Boulevard. Exhibits 2-4 and 2-5 provide a close-up shot of the Metro transit lines servicing some of the cities within the northerly and middle portions of the study corridor.

In the southern portion of the study corridor, from the I-10 to the I-110, Metro operates Line 215, which runs along Inglewood Avenue parallel to the corridor. Metro Rapid Lines 740 and 940, local bus Line 40, and Express Line 442 run along Hawthorne Boulevard while Line 211 operates along Prairie Avenue. The Metro Rail Green Line crosses the freeway running along the I-105 freeway and terminates at the Redondo

Beach Avenue Station. Finally, Metro Line 232 runs parallel to the study corridor along Sepulveda Blvd (SR-1). Exhibit 2-6 provides a close up shot of the Metro transit lines servicing some of the cities within the southerly portion of the I-405 corridor.

The Metrolink Ventura County Line crosses the northerly portion of the study corridor between Saticoy Street and Roscoe Boulevard while the Metrolink Antelope Valley Line runs southeast of the corridor to downtown Los Angeles. Exhibit 2-7 shows the Metrolink System Map for the southern California area.

Antelope Valley Transit operates Line 786, which runs on the I-405 corridor from the I-5 to the West Los Angeles area on Santa Monica Boulevard.

Santa Clarita Transit also operates many bus lines that run on the study corridor. They are Lines 792, 793, 797, and 798. These bus lines all terminate service at the northerly portion of the study corridor around Century City.

The Los Angeles Department of Transportation also operates two Commuter Express buses along this corridor. They are Lines 573 and 574.

Lastly, the City of Santa Monica's Big Blue Bus operates many bus lines within the proximity of the I-405 study corridor that provide transportation between residential neighborhoods and business centers.

Exhibit 2-4: Metro Area Map Servicing North I-405 Corridor

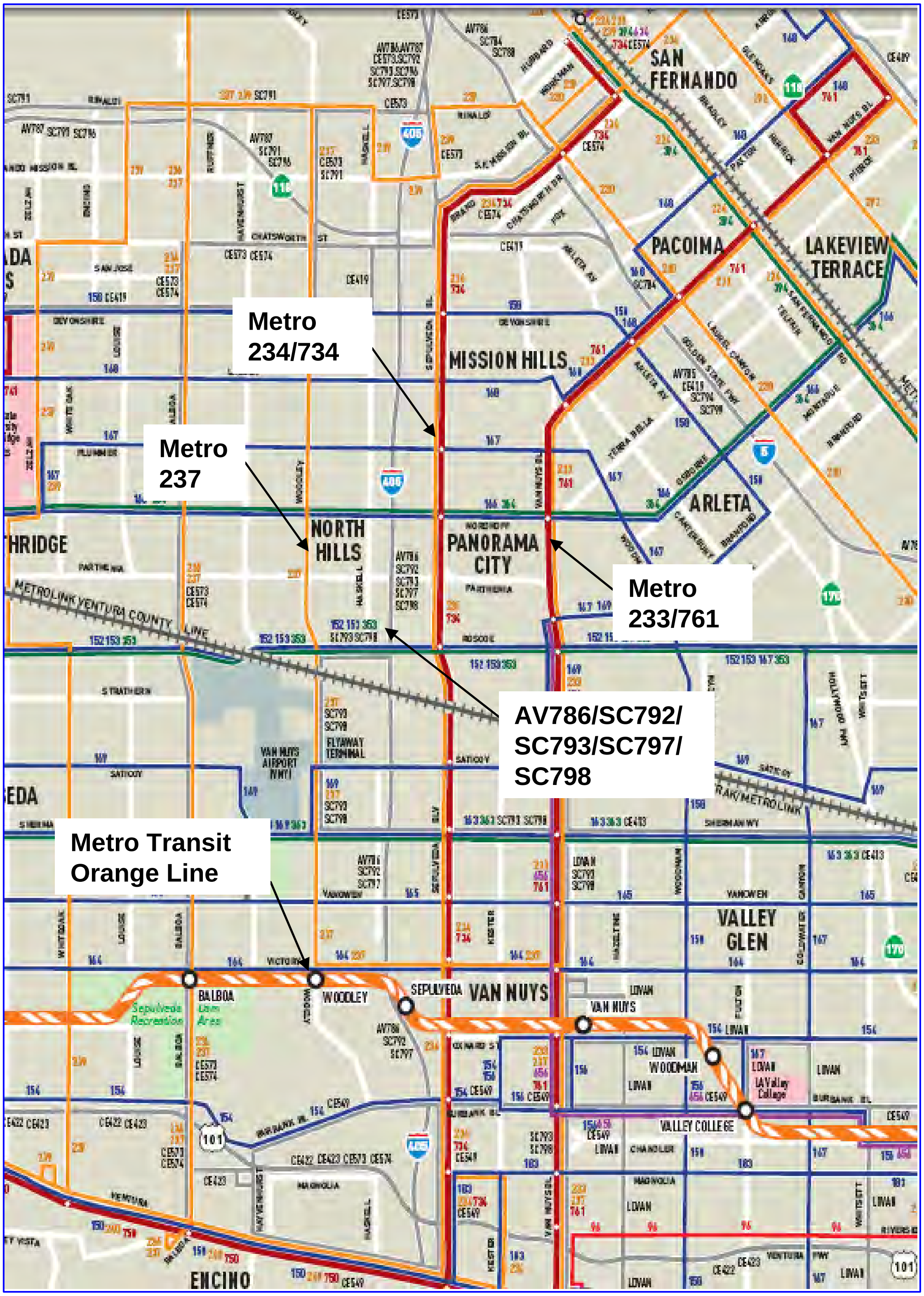


Exhibit 2-5: Metro Area Map Servicing Mid I-405 Corridor

Exhibit 2-6: Metro Area Map Servicing South I-405 Corridor

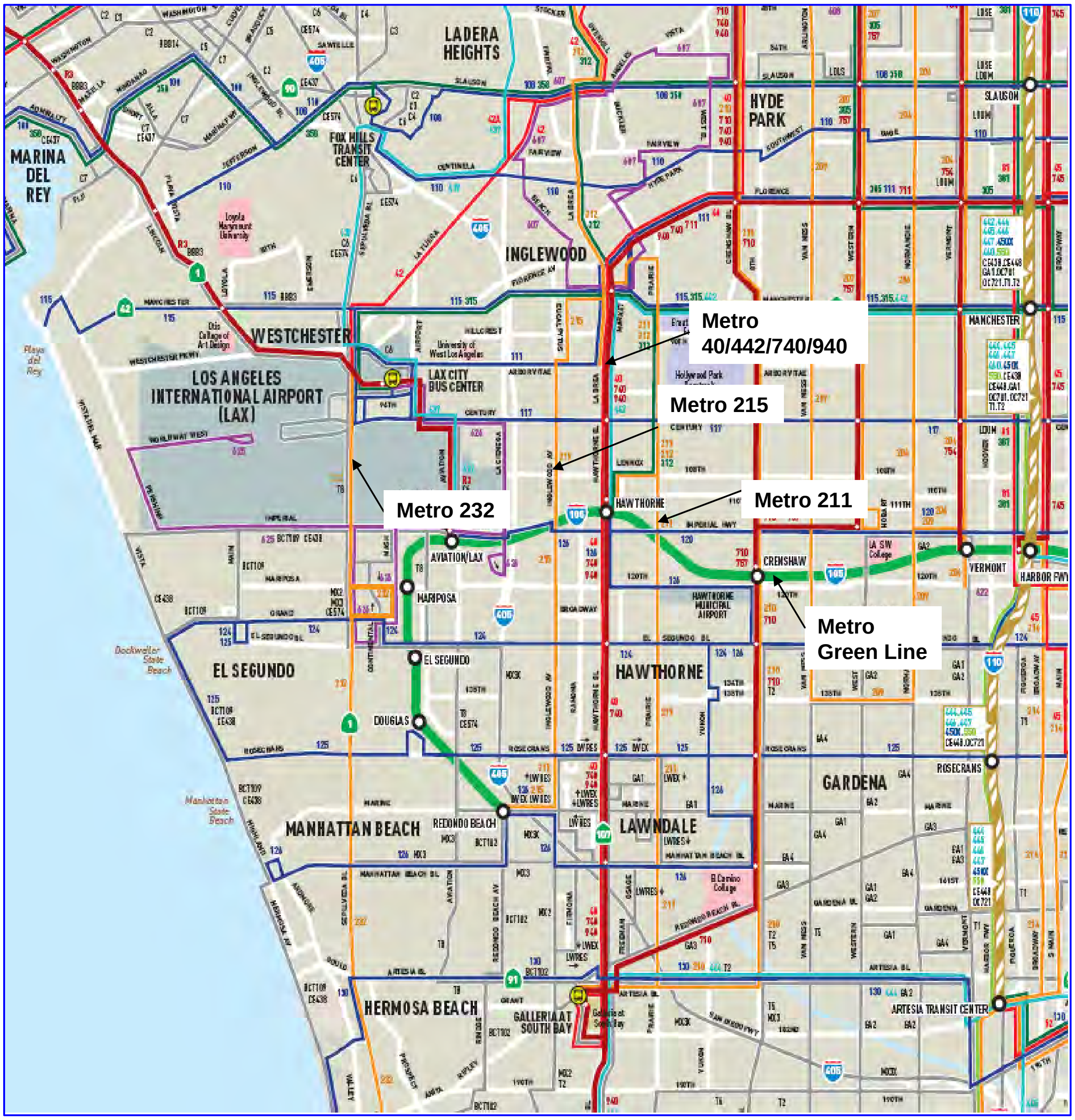


Exhibit 2-7 Metrolink System Map

Intermodal Facilities

A number of airports operate within the vicinity of the I-405 study corridor. Among the smaller airports include the Van Nuys Airport and Santa Monica Airport located in the northerly portion of the study corridor, and Hawthorne Municipal Airport and Torrance Municipal Airport located within the southerly portion of the study corridor. The following exhibits show the location of the respective airports relative to its location to the I-405 study corridor.

Exhibit 2-8 Santa Monica Airport

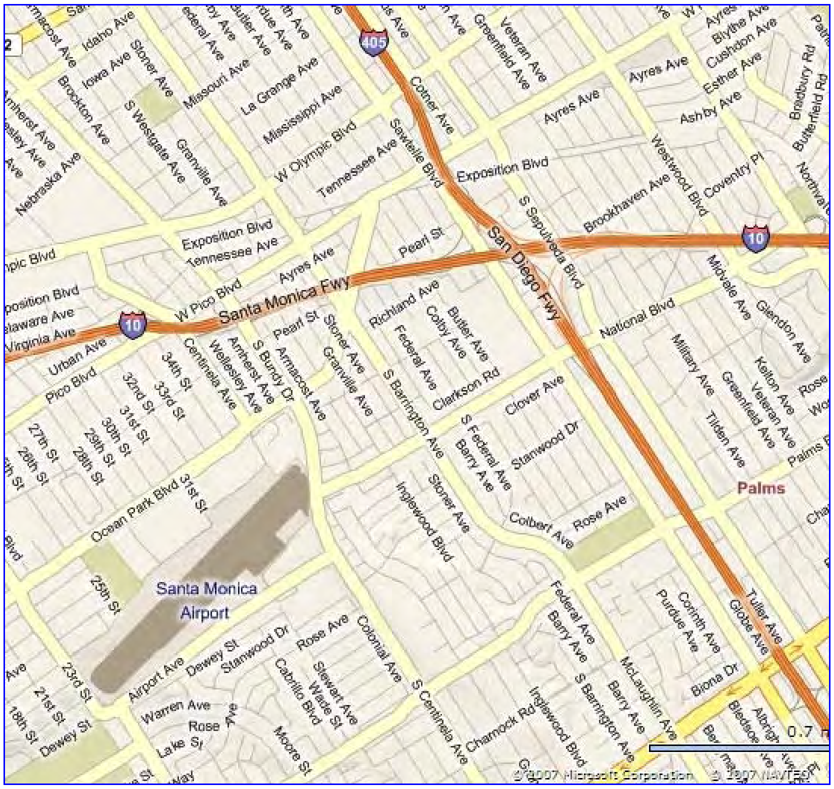


Exhibit 2-9 Van Nuys Airport

Exhibit 2-10 Hawthorne Municipal Airport

Exhibit 2-11 Torrance Municipal Airport

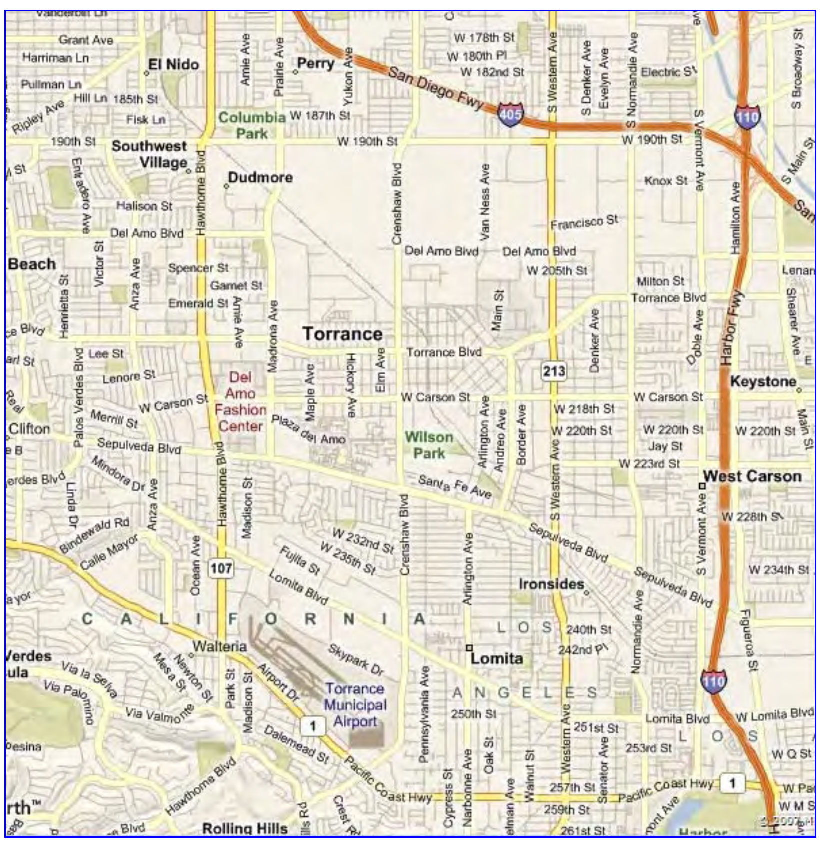
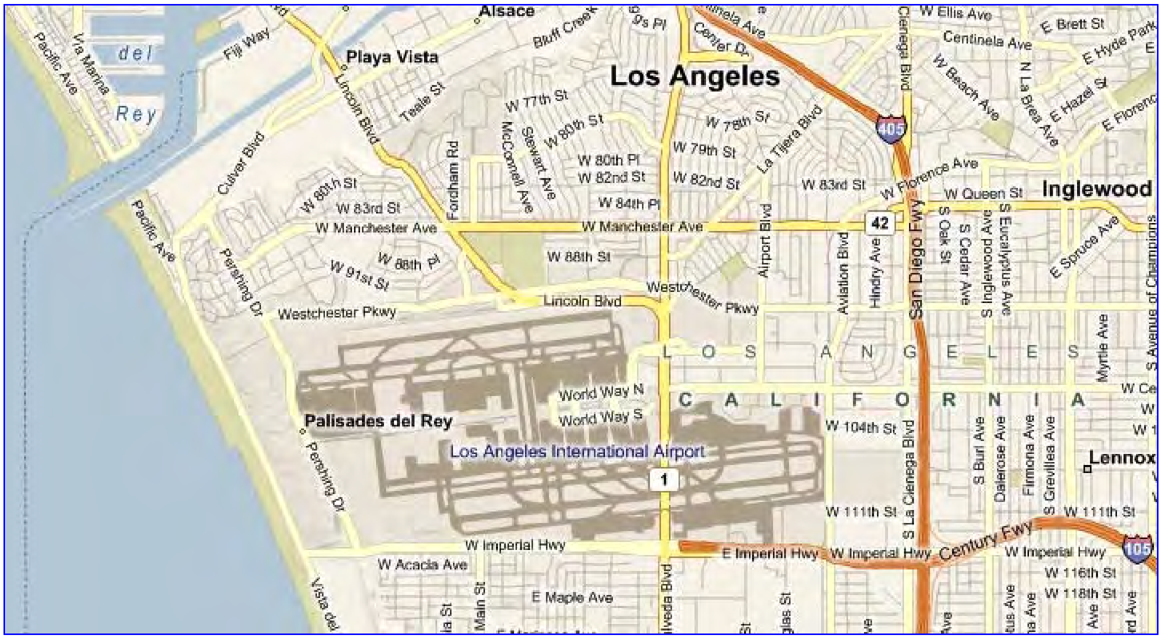


Exhibit 2-12: Los Angeles International Airport



Los Angeles International Airport (LAX), shown in Exhibit 2-11, is located off of the I-405 and I-105 Freeways. LAX is the world's fifth busiest passenger airport and ranks eleventh in air cargo tonnage handled.

In 2006, more than 61 million people traveled through LAX. A commerce leader, its ever-expanding air cargo system handled more than 2.1 million tons of goods. International freight is more than 50 percent of this total. LAX handled 70 percent of the passengers, 75 percent of the air cargo, and 95 percent of the international passengers and cargo traffic in the five-county Southern California region. Exhibit 2-12 shows the Los Angeles International Airports (LAX) Passenger Traffic Comparison by Terminal.

Exhibit 2-13: LA International Airports (LAX) Passenger Traffic Comparison by Terminal

Terminal	Type	Passenger Count January to December 2005	2006	% Change
Imperial Terminal	Arrival	2,221	2,697	21.43%
	Departure	2,154	2,882	33.80%
LAX T1	Arrival	5,049,887	4,828,195	-4.39%
	Departure	5,092,235	4,828,409	-5.18%
LAX T2	Arrival	2,945,327	2,992,262	1.59%
	Departure	2,942,103	3,005,327	2.15%
LAX T3	Arrival	2,019,833	2,048,725	1.43%
	Departure	2,380,991	2,465,245	3.54%
LAX T4	Arrival	5,687,870	5,636,517	-0.90%
	Departure	5,392,125	5,445,036	0.98%
LAX T5	Arrival	2,485,780	2,215,130	-10.89%
	Departure	2,462,723	2,261,503	-8.17%
LAX T6	Arrival	2,450,915	2,712,916	10.69%
	Departure	2,514,849	2,737,386	8.85%
LAX T7	Arrival	3,562,576	3,579,788	0.48%
	Departure	3,609,407	3,707,096	2.71%
LAX T8	Arrival	1,326,878	1,377,466	3.81%
	Departure	1,318,915	1,348,936	2.28%
Miscellaneous Terminal	Arrival	3,691	4,679	26.77%
	Departure	3,298	4,034	22.32%
TBIT	Arrival	4,760,825	4,670,204	-1.90%
	Departure	4,386,128	4,221,919	-3.74%

Special Event Facilities/Trip Generators

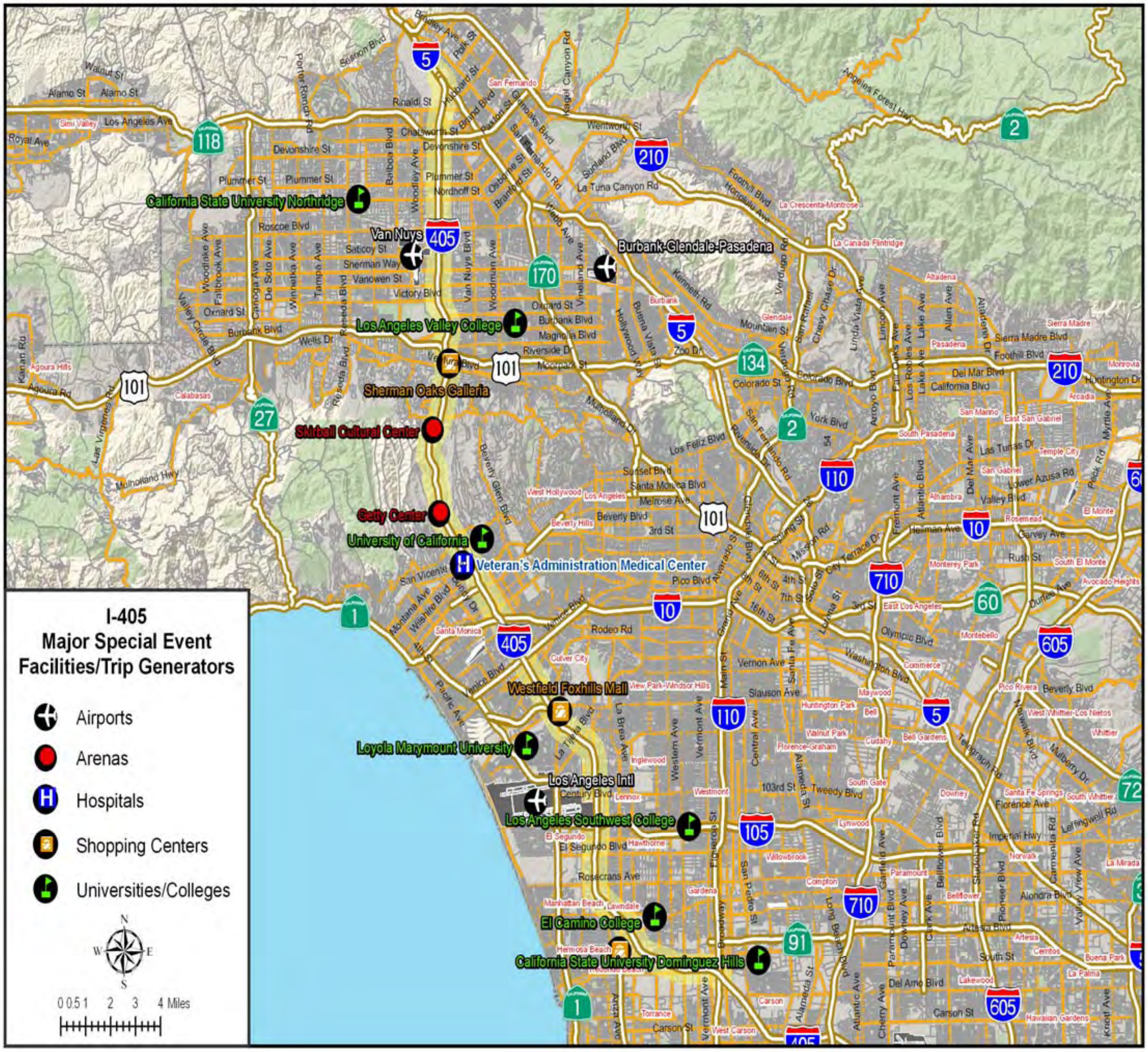
In addition to the Los Angeles International Airport and the major employment centers along the corridor, particularly the Westside and South Bay, there are major special event facilities that may generate significant trips along the I-405 corridor. A number of the most significant ones are shown in Exhibit 2-13. There are seven major colleges/universities near the I-405 corridor. California State University Northridge is located approximately three miles west of the study corridor and near the SR-118 (Simi Valley) Freeway. It is a public university with an estimated enrollment of 35,000 students. It offers Bachelors, Masters and Doctorate Degrees. Loyola Marymount

University (LMU) is located one mile west of the study corridor and south of the SR-90 Freeway. LMU is a private Catholic university, offering Bachelors, Masters, Doctorate and Law degrees. It has an estimated enrollment of approximately 9,000 students. El Camino College is located one mile east of the I-405 and west of the I-110 freeway. It is a two-year undergraduate college with an estimated student enrollment of 24,000. The University of California, Los Angeles (UCLA) is located in Westwood approximately one mile east of the 405 freeway. It is a public university offering Bachelors, Masters, and Doctorate degrees. It has an estimate enrollment of 40,000 students. Los Angeles Valley College is located three miles east of the study corridor and north of the US-101 freeway in the San Fernando Valley. The school is a part of the Los Angeles Community College District. It is a public two-year college with an estimated enrollment of 16,200 students. Los Angeles Southwest College is approximately three miles from the I-405 freeway and off the I-105 freeway. It is also part of the Los Angeles Community College District. It is a public two-year college with an estimated enrollment of 6,000 students. California State University Dominguez Hills is located approximately one mile from the I-405 freeway and east of the I-110 freeway. It is a four-year university offering undergraduate and graduate degrees. It has an estimated enrollment of 12,800 students. Approximately 40% of the students are enrolled in graduate programs. The majority of students are part-time evening students with an average course load of six units.

The I-405 corridor has two major medical facilities within its vicinity, the Veteran's Administration Medical Center and the UCLA Medical Center. The Veteran's Administration Medical Center is located less than one mile from the I-405 freeway and north of the I-10 freeway. It provides a full spectrum of inpatient and ambulatory care to over one million veterans residing in the primary service area of Los Angeles County, which has the largest concentration of veterans of any county in the United States. The Healthcare Center operates a 321-bed domiciliary that provides medical care in a therapeutic institutional environment to prepare veterans for re-entry into a community setting. It also contains two 120-bed nursing home care units located on the grounds and an active community nursing home program. The UCLA Medical Center is about one mile east of the I-405 freeway on the UCLA campus. It has over 600 beds and offers comprehensive care to all ages. More than 300,000 people come to the UCLA Medical Center each year to receive care from the world's most renowned providers.

In addition to these facilities, other major trip generators within the proximity of the I-405 study corridor include the Sherman Oaks Galleria off the US-101 interchange, the Skirball Cultural Center off Mulholland Drive, the Getty Center off Sunset Boulevard, the Westfield Foxhills Mall off the SR-90 interchange, and the South Bay Galleria off Hawthorne Boulevard.

Exhibit 2-14: Major Special Event Facilities/Trip Generators



3. EXISTING CONDITIONS

This section summarizes the analysis results of the performance measures used to evaluate the existing conditions of the I-405 corridor. The primary objectives of the measures are to provide a sound technical basis for describing traffic performance on the corridor.

The performance measures focus on four key areas:

- **Mobility** describes how well the corridor moves people and freight;
- **Reliability** captures the relative predictability of the public's travel time; and
- **Safety** captures the safety characteristics in the corridor such as collisions; and
- **Productivity** describes the productivity loss due to inefficiencies in the corridor.

MOBILITY

Mobility describes how well the corridor moves people and freight. The mobility performance measures are both readily measurable and straightforward for documenting current conditions and are readily forecast making them useful for future comparisons. Two primary measures are typically used to quantify mobility: delay and travel time.

Delay

Delay is defined as the total observed travel time less the travel time under non-congested conditions, and is reported as vehicle-hours of delay. Delay can be computed for severe congested conditions using the following formula:

$$(\text{Vehicles Affected per Hour}) \times (\textit{SegmentLength}) \times (\textit{Duration}) \times \left[\frac{1}{(\text{Congested Speed})} - \frac{1}{35\text{mph}} \right]$$

Where the vehicles are affected depends on the methodology used. Some methods assume a fixed flow rate (e.g., 2000 vehicles per hour per lane), while others use a measured or estimated flow rate. The distance is the length under which the congested speed prevails and the duration is the hours of congestion experience below the threshold speed.

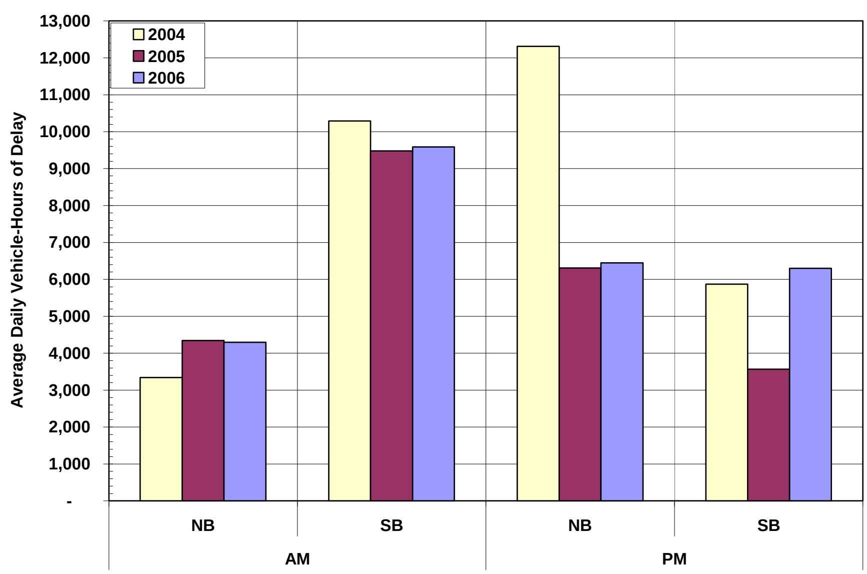
However, all delays can be computed by replacing the "35 mph" with "60 mph" in the previous formula. Different reports and studies use one of the two versions of this formula. The HICOMP report discussed next uses the 35 mph formula and assumes 2,000 vehicles per hour per lane are experiencing the delay. HICOMP therefore reports on only severe delay, while the PeMS results shown after use the 60 mph formula and use the "actual" number of vehicles reported by the detection systems and therefore represent overall delay. The results of these two sources are difficult to compare due to the methodological differences. Each is therefore discussed separately.

Caltrans HICOMP

The HICOMP report has been published annually by Caltrans since 1987[2]. Delay is presented as average daily vehicle-hours of delay (DVHD) and attempts to represent the sum of all the delay experienced by commuters on the corridor. For the Los Angeles HICOMP analysis, detection data are used. Two sample days are identified and used to compute delay to reflect "normal conditions". Days with much higher or lower delays are not included in the analysis and only severe delays (i.e., using 35 mph in the aforementioned formula) are reported. The average delay per vehicle per hour computed for the sample days is multiplied by 2,000 to maintain consistency among the different Caltrans districts. As mentioned in the introduction section, parts of the corridor where detection equipment was disconnected or where detection systems failed are not included the overall delay results.

Exhibit 3-1 shows the yearly delay trends from 2004 to 2006 for the AM and PM peak travel period for both directions along the I-405 corridor. As indicated, the southbound corridor had the most significant congestion during the AM peak period while the northbound experienced the most congestion during the PM peak period. The exhibit shows a sharp decline in the northbound PM peak period congestion from 2004 to 2005 and 2006. However, this decline could be due to the beginning of construction activities as detection systems were disconnected and no longer provided traffic data.

Exhibit 3-1: Average Daily Vehicle-Hours of Delay



2 Located at: http://www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/index.htm

Exhibit 3-2 shows the complete list of congested segments reported by the HICOMP report for the I-405 corridor. "Generalized" congested segments are presented so that segment comparisons can be made from one year to the next since a given congested segment may vary in distance or size from one year to the next as well as from day-to-day. However, it is important to reiterate that these trends are affected by the lack of detection data in construction areas and the overall reliability of detection equipment. This may well explain the drop in 2005 during the PM peak period.

Exhibits 3-3 and 3-4 provide maps illustrating the 2006 congested segments during the AM and PM peak commute periods for the I-405. The approximate locations of the congested segments, the duration of that congestion, and the reported recurrent daily delay are also shown.

Based on the HICOMP results, the most congested segment on the corridor varied from year to year (most likely due to construction and detection availability). The highest delays were reported for the northbound segment during the PM peak period between the Sepulveda Boulevard and Chalon Road. Delay in this segment totaled 8,425 hours in 2004.

Exhibit 3-2: HICOMP Hours of Delay for Congested Segments 2004-2006

Period	Dir	Generalized Congested Area	Generalized Area Congested Hours of Delay		
			2004	2005	2006
AM	NB	Carson St to Rosecrans Ave			1,186
		South of Main St to Inglewood Ave	1,254		
		Main St to Inglewood Ave		1,875	
		I-105 to Culver Bl			3,113
		104th St to La Tijera Bl	1,806		
		Manchester/La Cienega to Culver Bl		2,467	
		Sepulveda Bl to SR-2 (Santa Monica Bl)	281		
	SB	San Fernando Mission to US-101			5,715
		San Fernando Mission Bl to Nordhoff St	997		
		I-118 to Ventura Bl		6,104	
		Nordhoff St to Burbank Bl	5,471		
		Burbank Bl to Chalon Rd	3,517		
		Ventura Bl/US-101 to Bel Air Crest			3,222
		Ventura Bl to Moraga Dr		3,048	
		Bel Air Crest to Sunset Bl			566
		Moraga Dr to Waterford S		84	
		Olympic Bl to Venice Bl		148	
		La Cienega/North of Imperial Hwy to Crenshaw Bl	306		
		I-105 to Western Ave		93	
		Imperial/I-105 to 135th St			85
AM PEAK PERIOD SUMMARY			13,631	13,819	13,886
PM	NB	South of Main St to Crenshaw Bl	354		
		La Tijera Bl to Sepulveda Bl			5,145
		Howard Hughes Pkwy to Sepulveda Bl		4,405	
		Sepulveda Bl to Chalon Rd	8,425		
		Chalon Rd to Lassen St	3,529		
		Sepulveda Bl to Ventura Bl		584	
		Mulholland Dr to Lassen St			1,302
		US-101 to s/o Nordoff St		1,319	
	SB	Sunset Bl to SR-2 (Santa Monica Bl)	531		
		Ohio Ave to Braddock Dr			961
		SR-2 (Santa Monica Bl) to Jefferson Bl	3,060		
		Olympic Bl to Sepulveda Bl		1,169	
		104th St to Rosecrans Ave/Hindry Ave	1,712		
		Century Bl to Rosecrans Ave		922	2,152
		135th St to Crenshaw Bl/182 St			972
		Rosecrans Ave/Hindry Ave to Van Ness Ave	567		
		Rosecrans Ave to Van Ness Ave		241	
		Crenshaw Bl/182nd St to Carson St			2,213
		Van Ness Ave to Carson St		1,235	
PM PEAK PERIOD SUMMARY			18,179	9,875	12,746
TOTAL CORRIDOR CONGESTION			**31,810**	**23,694**	**26,632**

Exhibit 3-3: 2006 AM Peak Period HICOMP Congested Segments Map

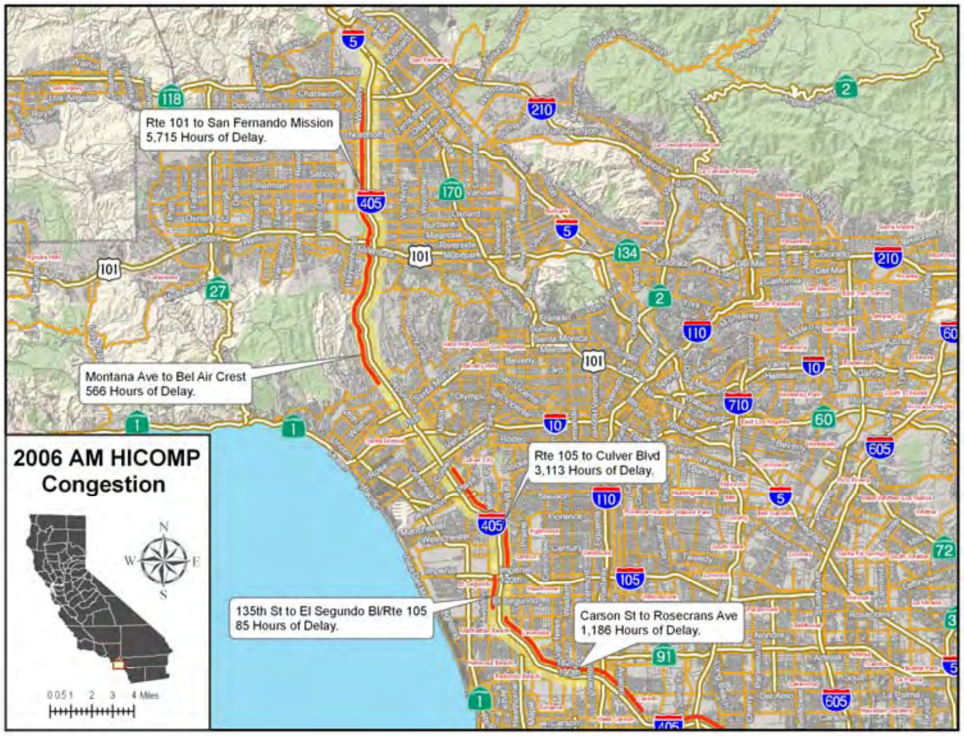
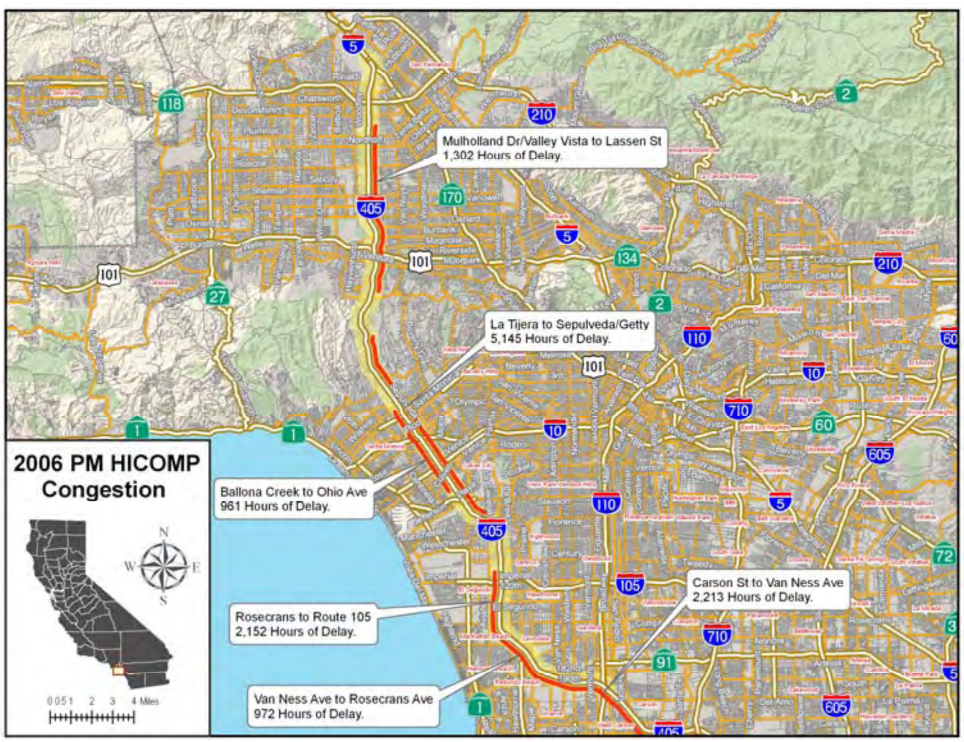


Exhibit 3-4: 2006 PM Peak Period HICOMP Congested Segments Map



Freeway Performance Measurement System (PeMS)

Exhibit 3-5 is a graphic from PeMS showing the I-405 corridor vehicle detection stations (VDS) and the “good” (green) and “bad” (red) VDS data available for November 6, 2007. As illustrated in the exhibit, detection on this day was relatively good along the corridor except for the segment between the SR-90 and the West Hollywood area and the segment south of the US-101 interchange. This is due to the construction activity in that area where the detection system is rendered inoperable. This is the case since construction started in late 2003. A significant gap in the vehicle detection exists from 2004.

Exhibit 3-6 is a chart showing the percentage of “good, available” data for I-405 for each month between 2001 and mid-2007. It shows the variability of available data over time. The southbound detection was slightly better than for the northbound direction in 2002 and 2003. However, both directions had less than 75 percent available throughout the period analyzed, with the best detection available in 2003. Northbound detection was better in later periods starting in 2006, but overall detection availability fell below 70 percent. While not perfect, having detection covering a range of years, seasons, and locations on the corridor may help the study team by adding another dimension to the analysis, particularly concerning seasonal and time of day conditions.

Exhibit 3-5: PeMS Sensor Data Quality November 2007

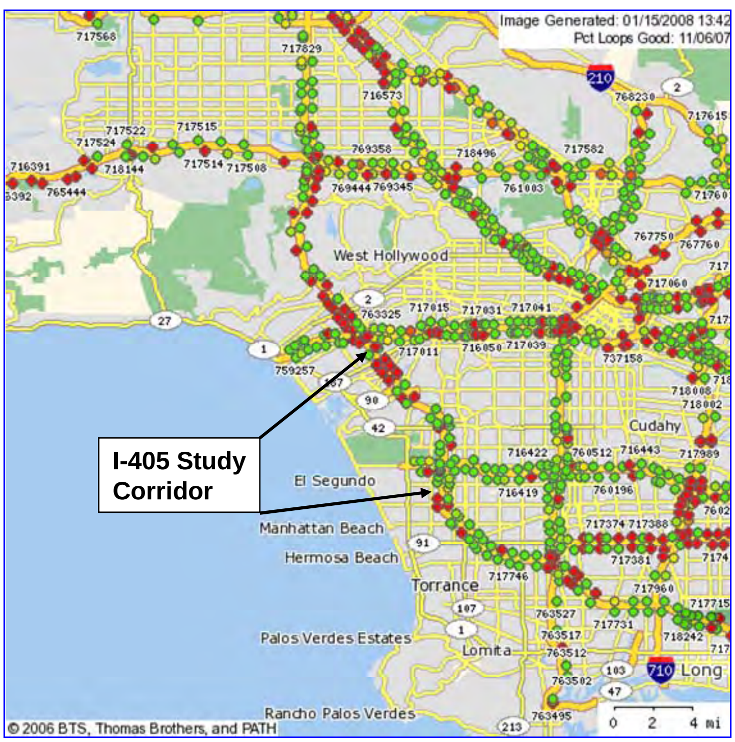
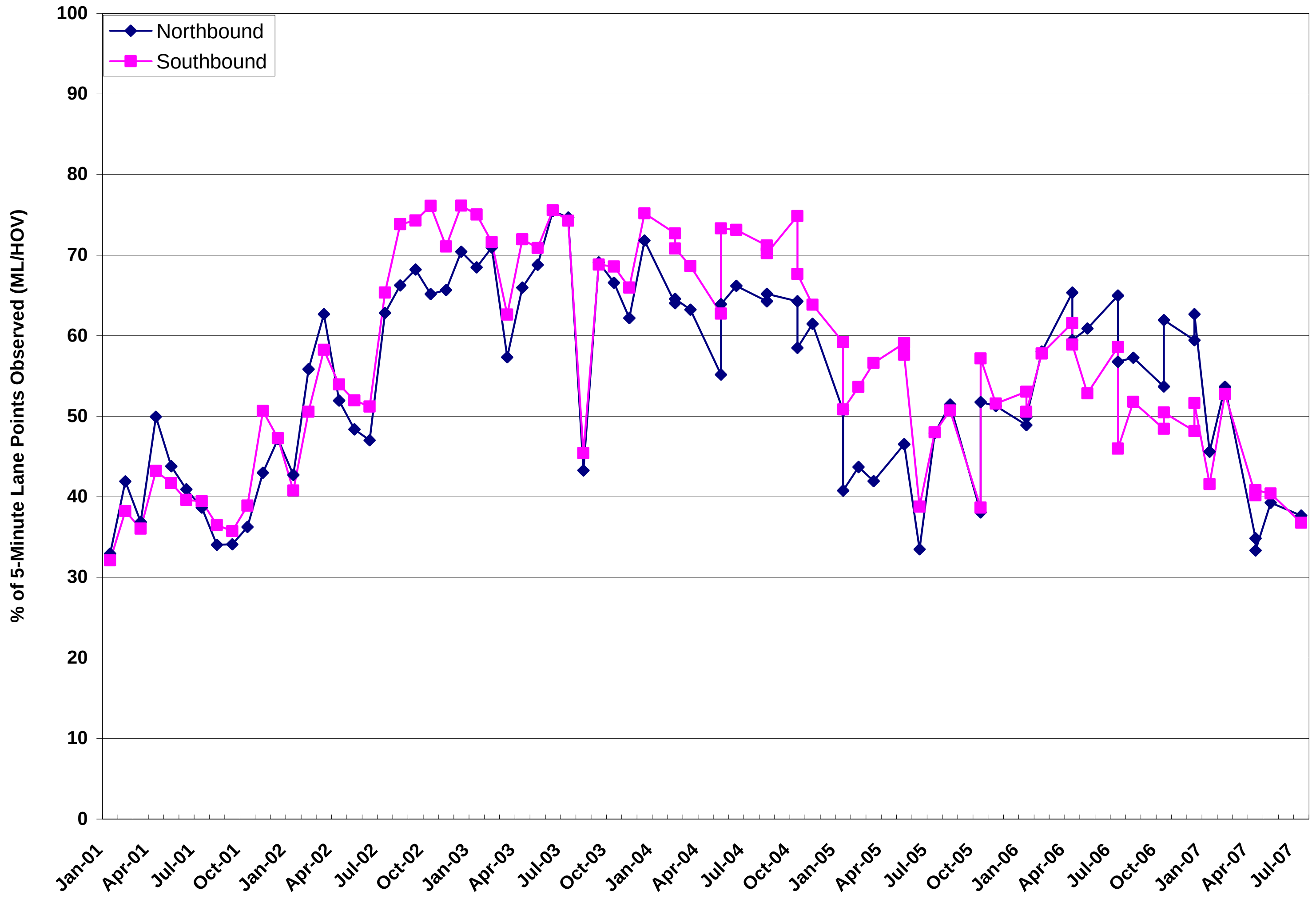


Exhibit 3-6: I-405 PeMS Sensor Data Quality 2001-2007



Since the best data was observed in 2003, the study team, in coordination with SCAG, Caltrans and other stakeholders, decided to use 2003 as the baseline year for micro simulation model development and calibration. Again, this decision is not ideal. The model can be updated in the future as more data becomes available from more recent years.

As a result, the study compiled three years of PeMS data, 2001 to 2003 to complement the HICOMP data previously discussed (which covers the period from 2004 through 2006, but with less data).

Unlike HICOMP where delay is only considered and captured for speeds below 35 miles per hour and applied to an assumed output or capacity volume of 2000 vehicles per hour, delays presented herein using PeMS represent the difference in travel time between "actual" conditions and free flow conditions at 60 miles per hour, applied to the actual output flow volume collected from a vehicle detector station. The total delay by time period for the corridor for each direction is shown in Exhibits 3-7 and 3-8.

Total delay along the I-405 study corridor was computed for four time periods: AM peak (6:00 AM to 9:00 AM), Midday (9:00 AM to 3:00 PM), PM peak (3:00 PM to 7:00 PM), and evening/early AM (7:00 PM to 6:00 AM). Delay is computed as the difference in estimated travel time and a hypothetical travel time at a threshold speed of 60 miles per hour. This is different from the State of the System/HICOMP reporting methodology, which calculates delay using the "severe" threshold speed of 35 mph.

Exhibits 3-7 and 3-8 show the three-year trend in overall weekday delay for the I-405 corridor (i.e., excluding weekends and holidays) for the three years analyzed for the northbound and southbound directions, respectively. There is also a 90-day moving average to "smooth" out the day-to-day variations and better illustrate the seasonal and annual changes in congestion over time. As indicated in Exhibits 3-7 and 3-8, both directions of travel experience the highest levels of delay during the PM peak period increasing annually from 2001 through 2003. As indicated in these two exhibits, delay has increased significantly from 2001 to 2002 and remained relatively consistent to 2003 at approximately 25,000 vehicle-hours of delay each day in each direction. The low delay in 2001 is likely due to the significant drop in travel, congestion, and delay, following the events of September 11, 2001. However, the lower percent availability of detection data probably contributed to this drop as well. As indicated in both charts, most of the daily congestion occurs during the PM peak period.

Also note the variability of total daily delay over the period analyzed. For instance, northbound delays ranged from 18,000 to 32,000 during 2003. That is why comprehensive data is critical. It is difficult, if not impossible, to accurately determine which days are "typical" when variations are this significant.

Exhibit 3-7: I-405 Northbound Average Daily Delay by Time Period 2001-2003

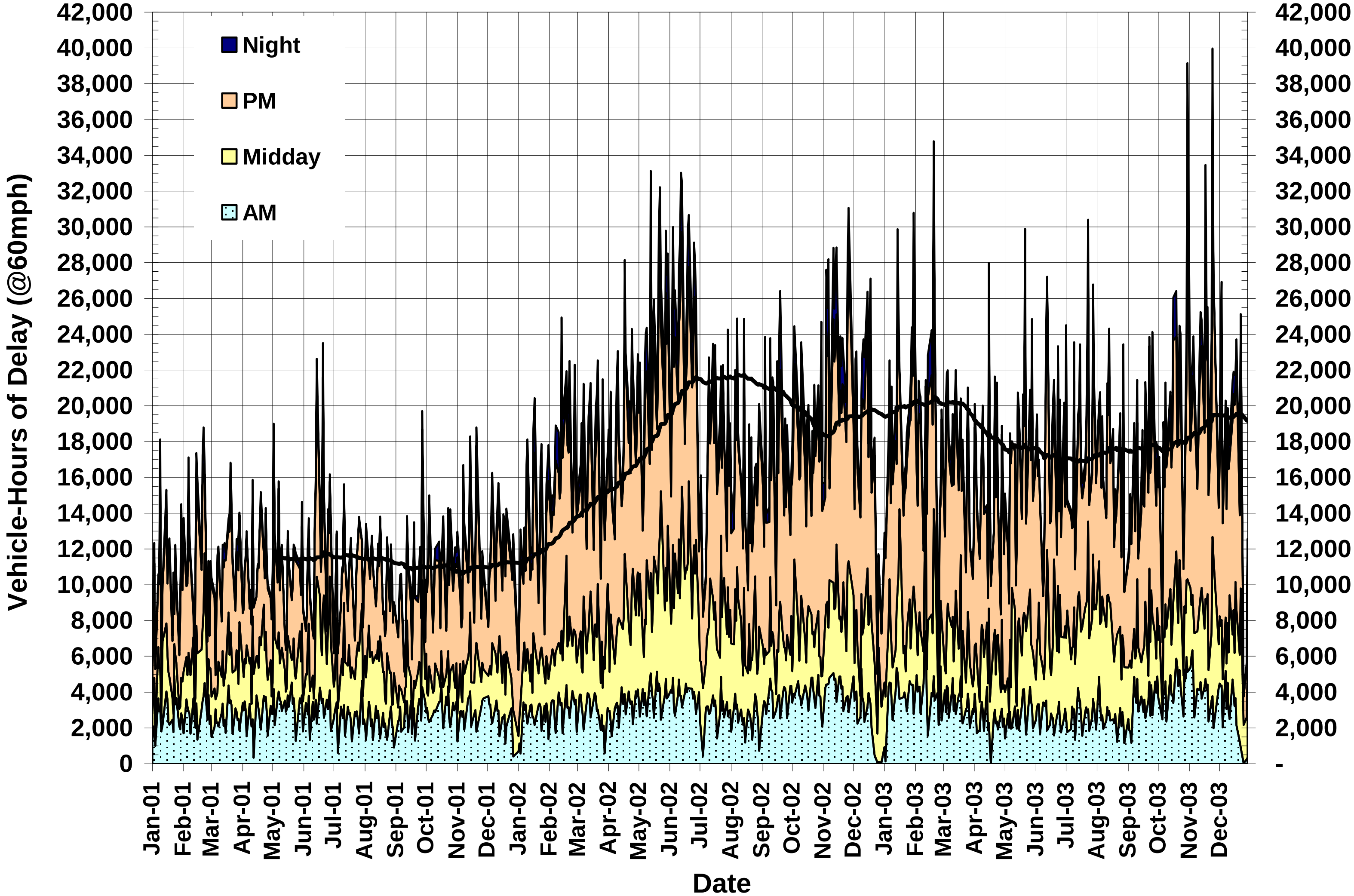
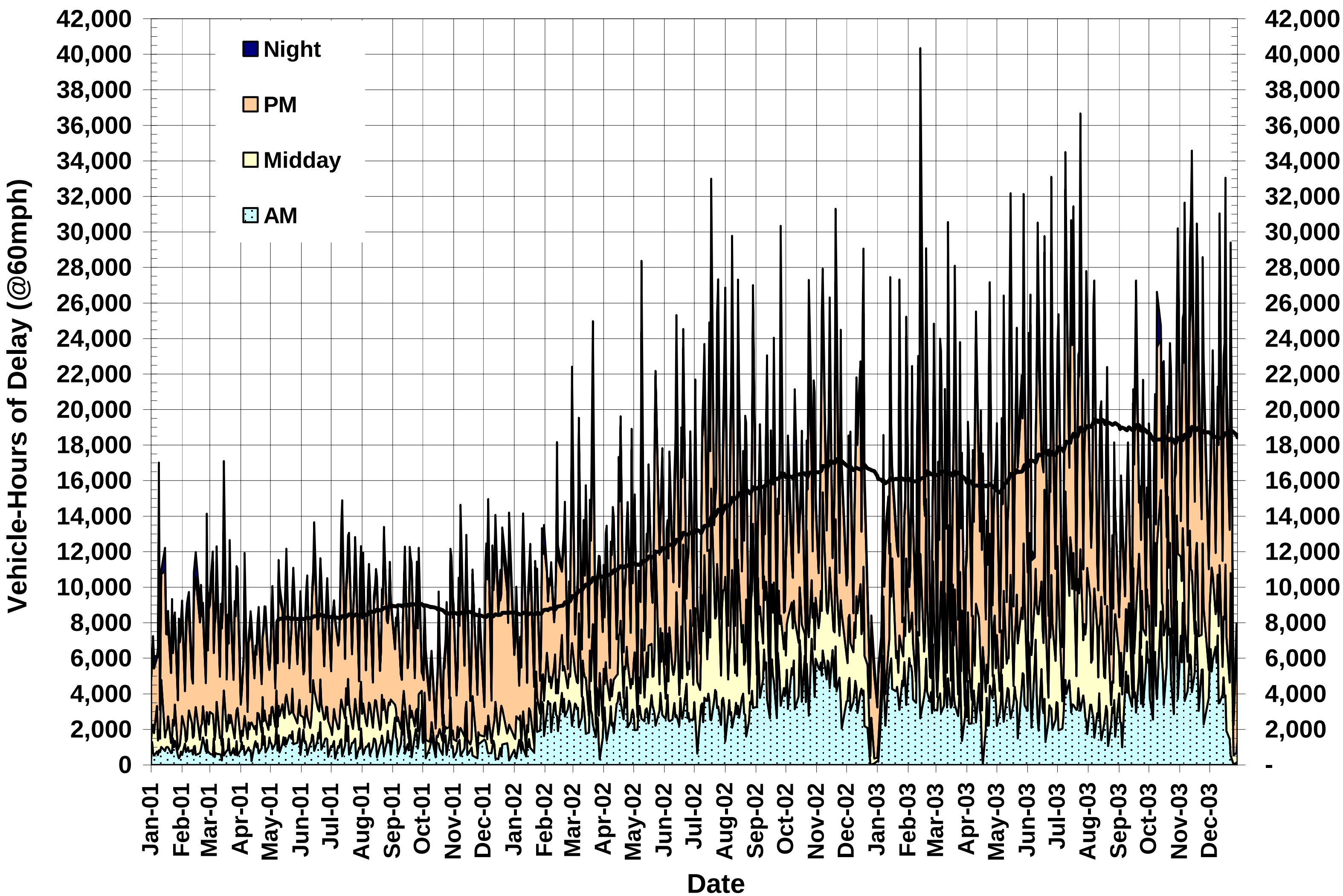
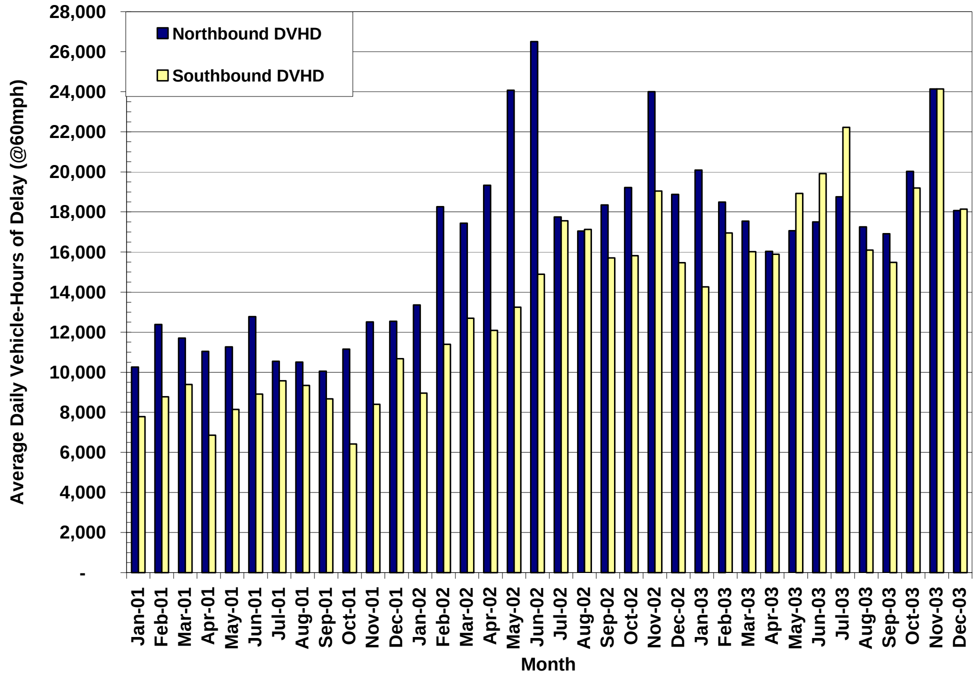


Exhibit 3-8: I-405 Southbound Average Daily Delay by Time Period 2001-2003



The next set of exhibits provides additional delay characteristics and trends. Exhibit 3-9 illustrates the average daily weekday delay by month for the respective directions. As indicated in this exhibit, the average weekday delay varies month to month, ranging from approximately 10,000 vehicle-hours to 24,000 vehicle-hours. The northbound corridor experienced more congestion in 2001 and 2002 than southbound, but in 2003 the southbound corridor experienced more congestion than northbound, which may be due to the various construction activities in the corridor during that time.

Exhibit 3-9: Average Weekday Delay by Month 2001-2003

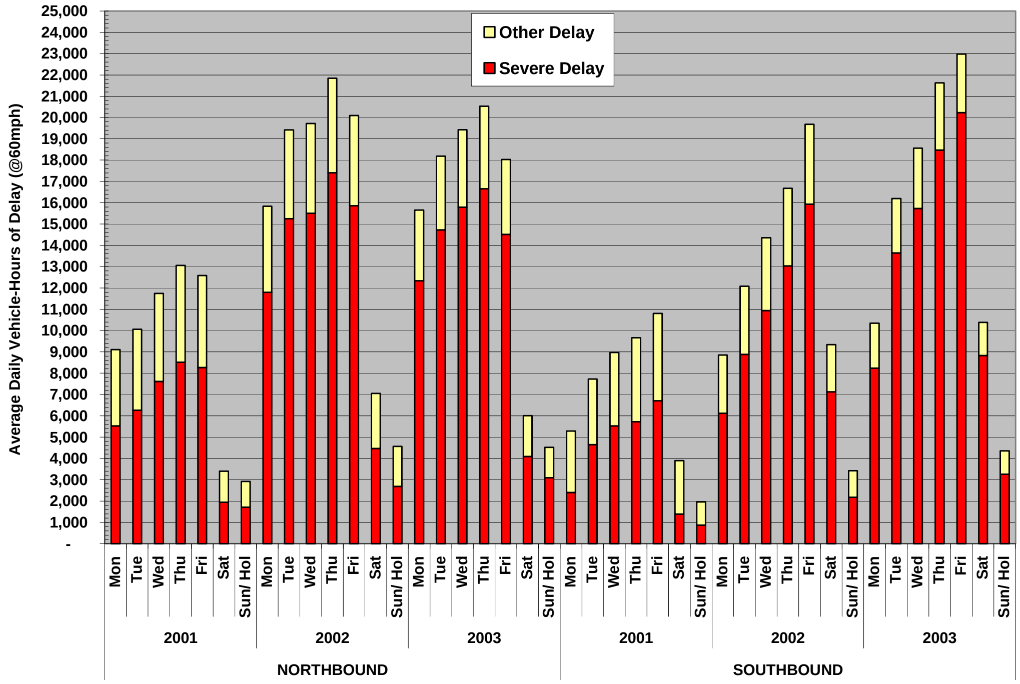


Delays presented to this point represent the difference in travel time between "actual" conditions and free flow conditions at 60 miles per hour. This delay can be segmented into two components as shown in Exhibits 3-10:

- Severe delay – delay that occurs when speeds are below 35 miles per hour; and
- Other delay – delay that occurs when speeds are between 35 miles per hour and 60 miles per hour.

Severe delay in Exhibit 3-10 represents breakdown conditions and is generally the focus of congestion mitigation strategies. On the other hand, "other" delay represents conditions approaching the breakdown congestion, leaving the breakdown conditions, or areas that do not cause widespread breakdowns, but cause at least temporary slowdowns. Although combating congestion requires the focus on severe congestion, it is important to review "other" congestion and understand its trends. This could allow for pro-active intervention before the "other" congestion turns into severe congestion. As indicated in Exhibit 3-10, the northbound direction on Thursdays experienced the highest “severe” delays of more than 20,000 vehicle-hours. In the southbound direction, Fridays experienced the highest “severe” delays, significantly increasing in 2003. Again, these differences may be due to actual trends, construction activities, or detection quality differences.

Exhibit 3-10: Average Delay by Day of Week by Severity 2001-2003



Another way to understand the characteristics of congestion and related delays is shown in Exhibits 3-11 and 3-12, which summarize average weekday hourly delay for the three years analyzed. Exhibit 3-11 shows the northbound average weekday hourly delay from 2001 through 2003. Peak hourly delay in the northbound direction is approximately 2,900 vehicle-hours occurring at 5PM. Exhibit 3-12 shows the southbound average weekday hourly delay from 2001 through 2003. Peak hourly delay in the southbound direction is approximately 2,500 vehicle-hours also occurring at 5PM.

While the northbound hourly delay has remained relatively the same from 2002 to 2003, the southbound had experienced significant increase in hourly delay from 2002 to 2003. As shown in both exhibits, the duration of congestion is much longer during the PM peak period and starts around 2 pm and lasts until 7 pm. The AM peak period on the other hand lasts only about 3 hours, from approximately 6:30 am and lasts until 9:30 am. The maximum delay during the AM peak period occurs at 8:00 am is about half of the maximum delay during the PM peak period, which occurs at 5:00 pm. Over time, it is important to evaluate the peak “spreading” trends and whether projects delivered not only reduce total delay, but also reduce the peak congested periods.

Exhibit 3-11: Northbound Average Weekday Hourly Delay 2001-2003

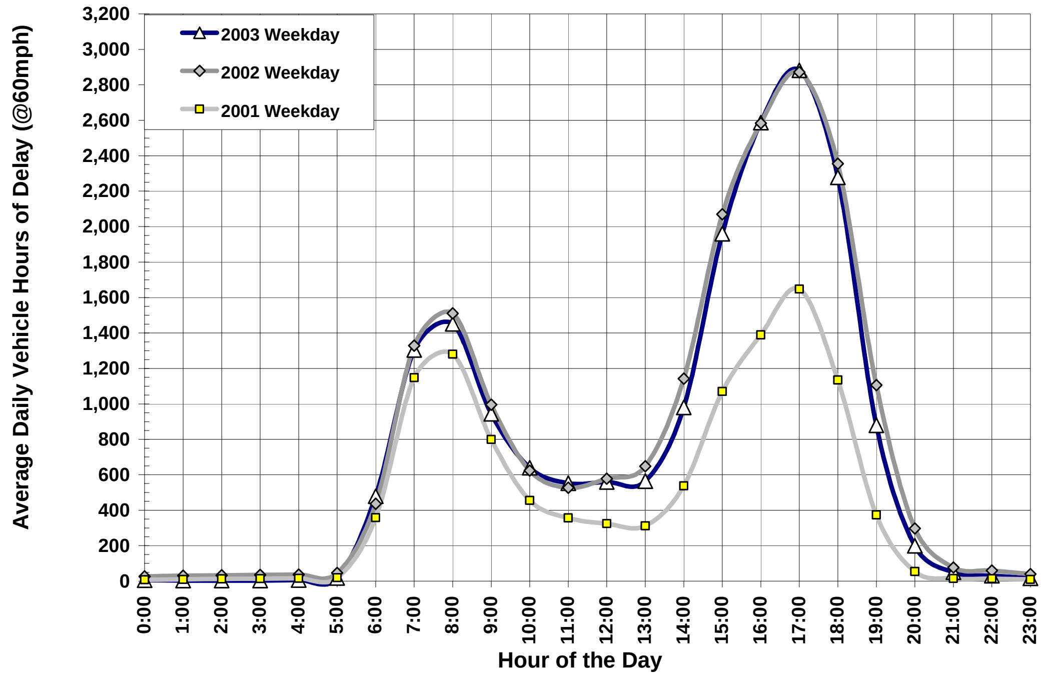
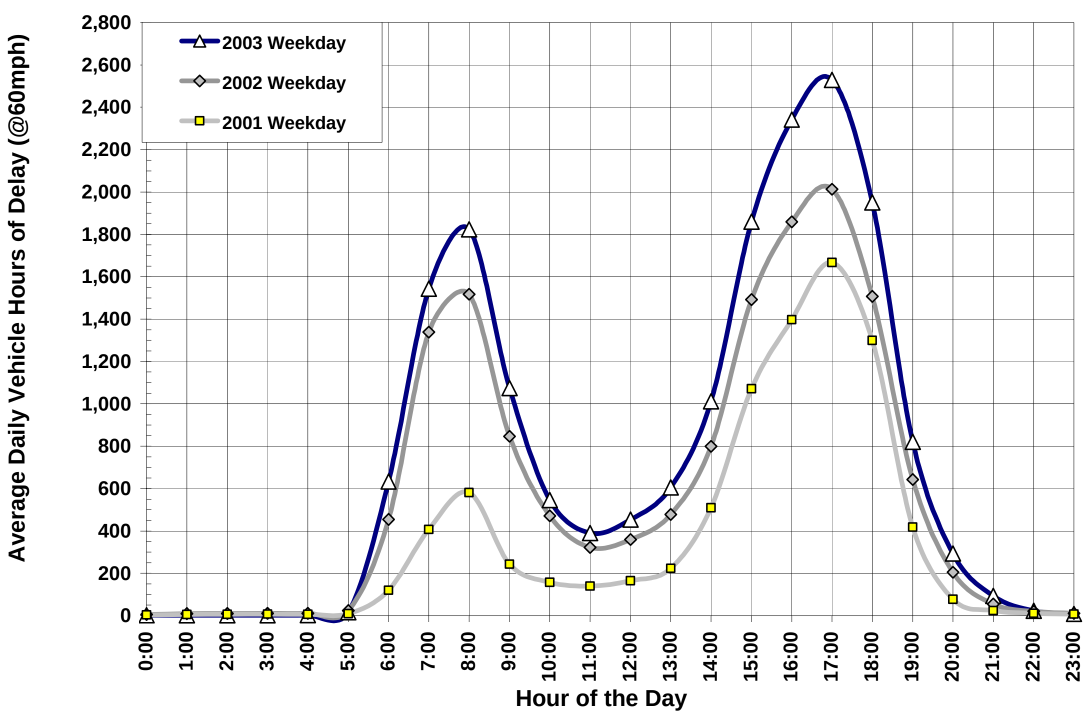


Exhibit 3-12: Southbound Average Weekday Hourly Delay 2001-2003



Travel Time

Travel time is reported as the amount of time it takes for a vehicle to traverse between two points on a corridor. For the I-405 corridor, this travel time is the time to traverse the 36 miles on I-405 corridor from I-110 to I-5. Travel time on parallel arterials was not included for this analysis. For this performance measure, PeMS was used to analyze travel time.

Exhibits 3-13 and 3-14 illustrate the travel times assessed for this I-405 corridor section. As indicated both the northbound and southbound corridors had average travel time of approximately 51 minutes during the AM peak hour (7-8AM) and approximately 61 minutes during the PM peak hour (4-5PM) in 2003. Unlike most other corridors with directional commute congestion, this corridor has mirror-like conditions in the two opposite directions. However, there was a significant increase during the PM peak period in the northbound direction and in the AM peak period in the southbound direction from 2001 to 2002. This is likely due to the construction activities around the I-10 and, to a lesser extent, due to the increased availability in detection data.

Exhibit 3-13: Northbound Travel Time by Time of Day 2001-2003

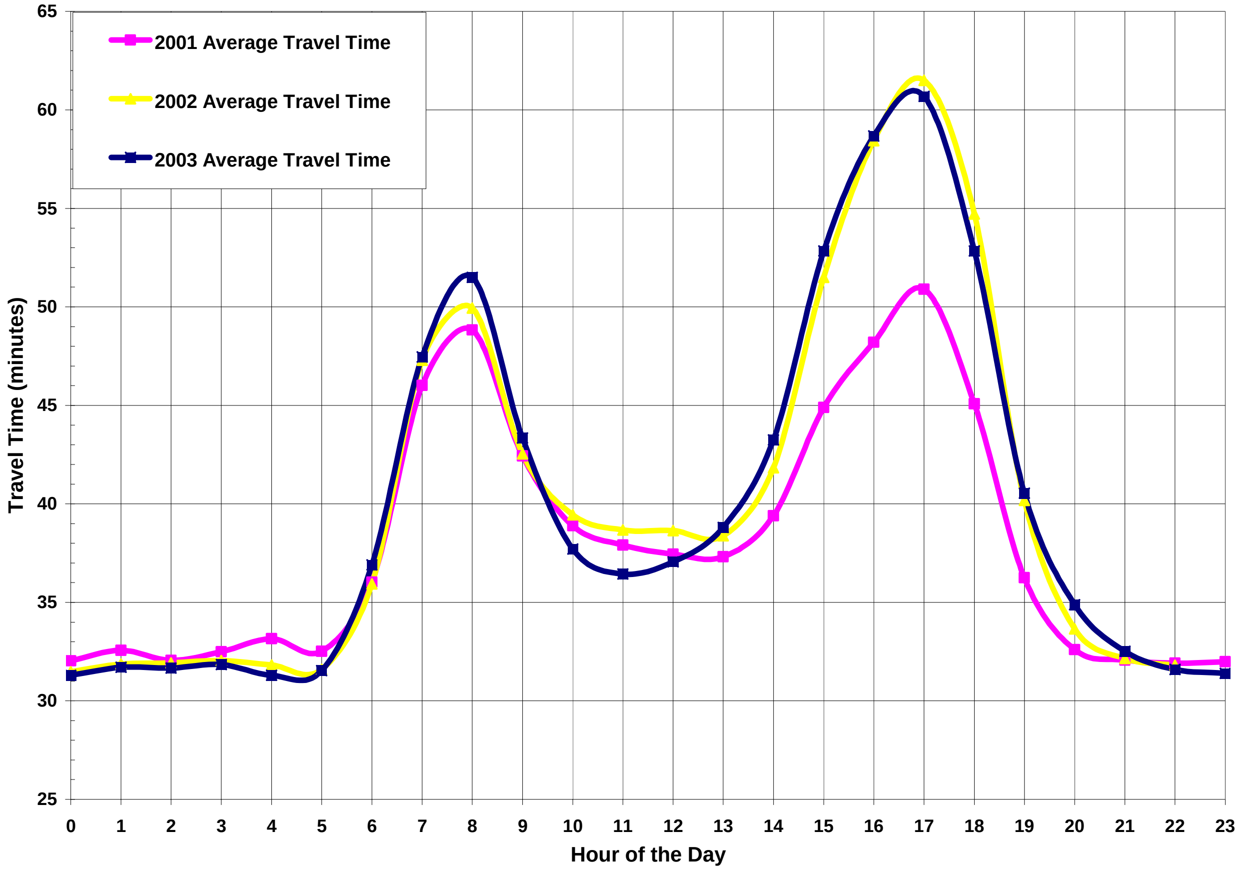
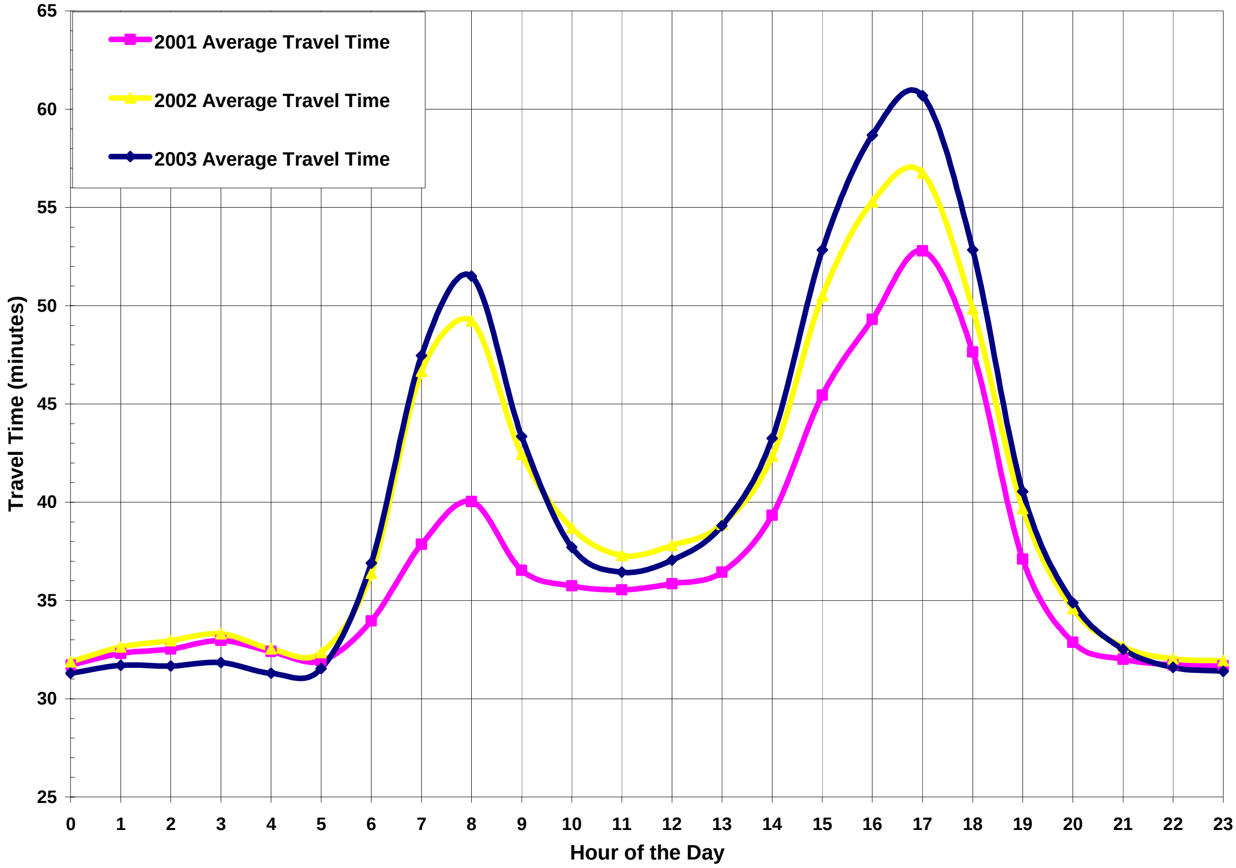


Exhibit 3-14: Southbound Travel Time by Time of Day 2001-2003



RELIABILITY

Reliability captures the relative predictability of the public's travel time. Unlike mobility, which measures how many people are moving at what rate, the reliability measure focuses on how much travel time varies from day to day.

PeMS was used to calculate travel time variability. The reliability, or variability, in travel time was estimated. From the wide range of travel times from average to the maximum, the 95 percentile provides a reasonable expected peak travel time at any given day.

Exhibits 3-15 to 3-20 illustrate the variability of travel time along I-405 for weekdays averaged throughout the indicated year. As evident in the exhibits, travel times can range as much as 15% or more (about 10 minutes longer) of the mean travel time during the peak hours. Daily reliability will vary within this range depending on the number and extent of incidents occurring during travel. Travel times of less than the mean are infrequent, typically occurring during the day preceding or following a holiday weekend. Overall, travel time reliability improved somewhat in 2003 from that of previous years, especially in the southbound direction.

Exhibit 3-15: Northbound Travel Time Variability 2001

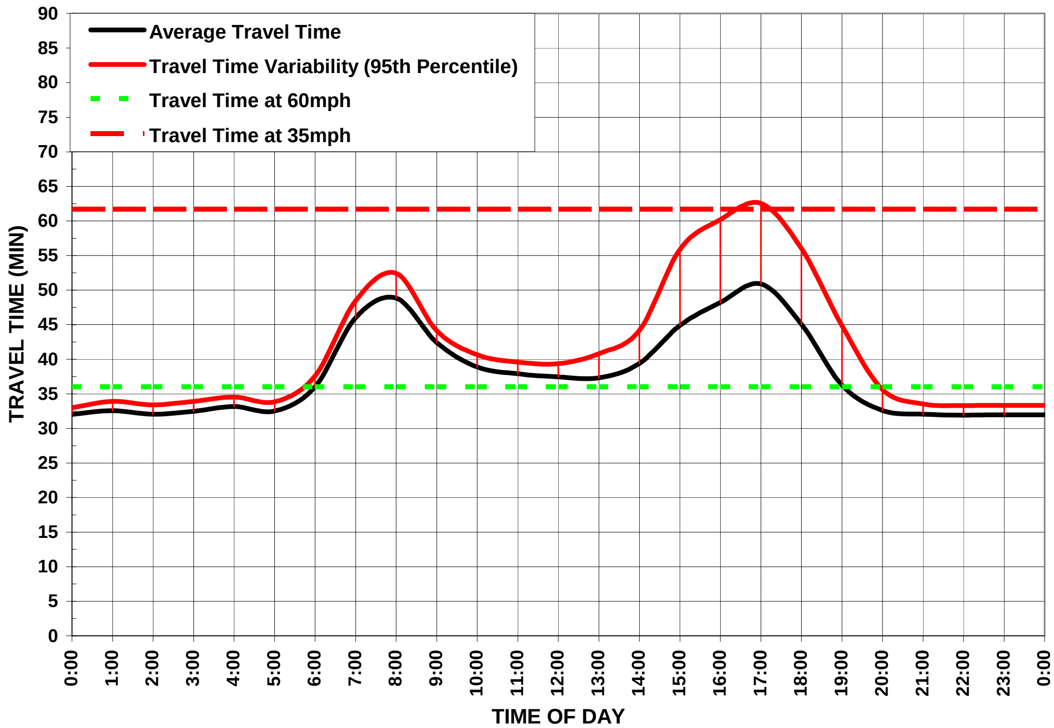


Exhibit 3-16: Southbound Travel Time Variability 2001

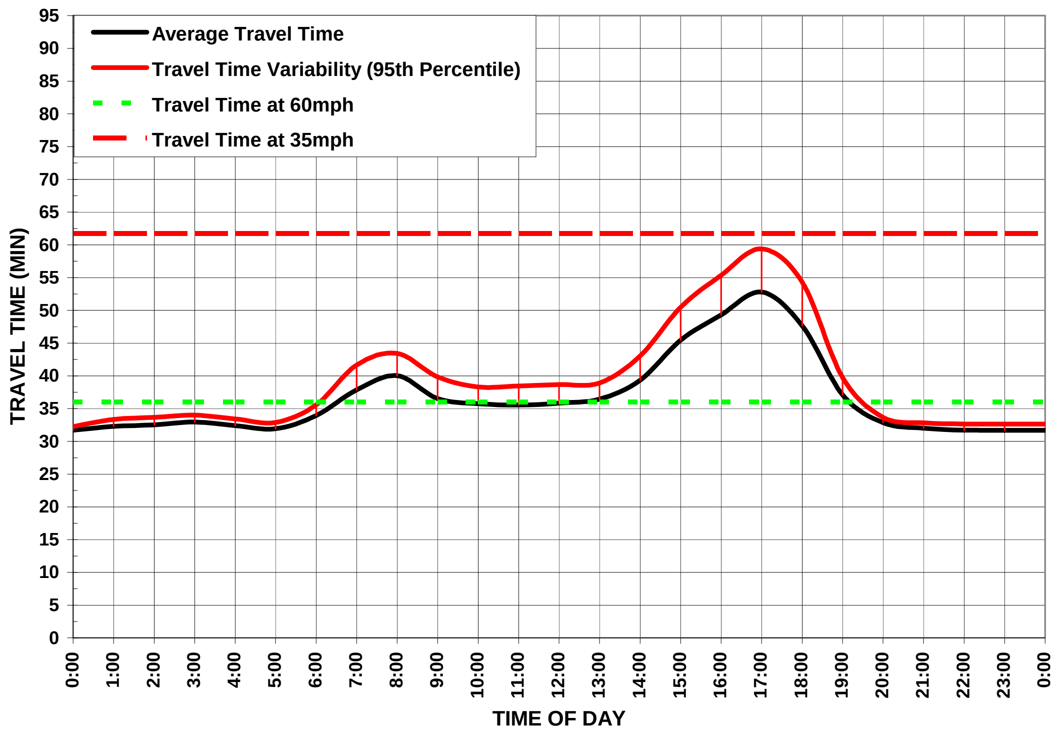


Exhibit 3-17: Northbound Travel Time Variability 2002

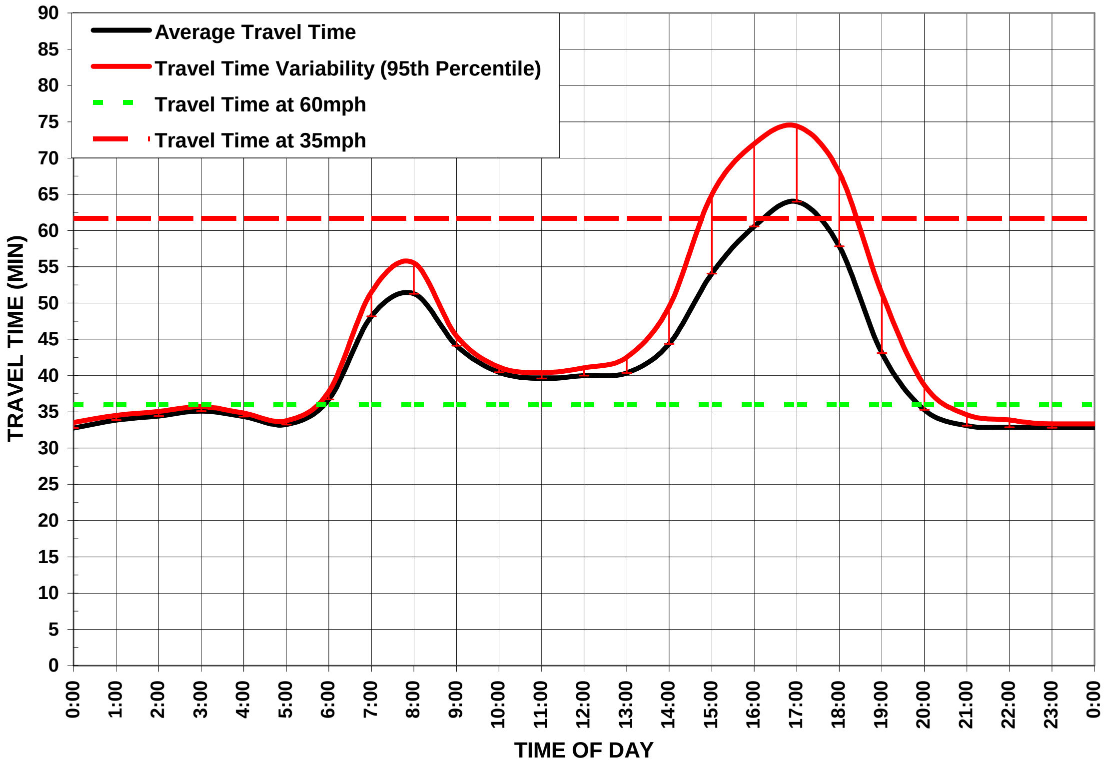


Exhibit 3-18: Southbound Travel Time Variability 2002

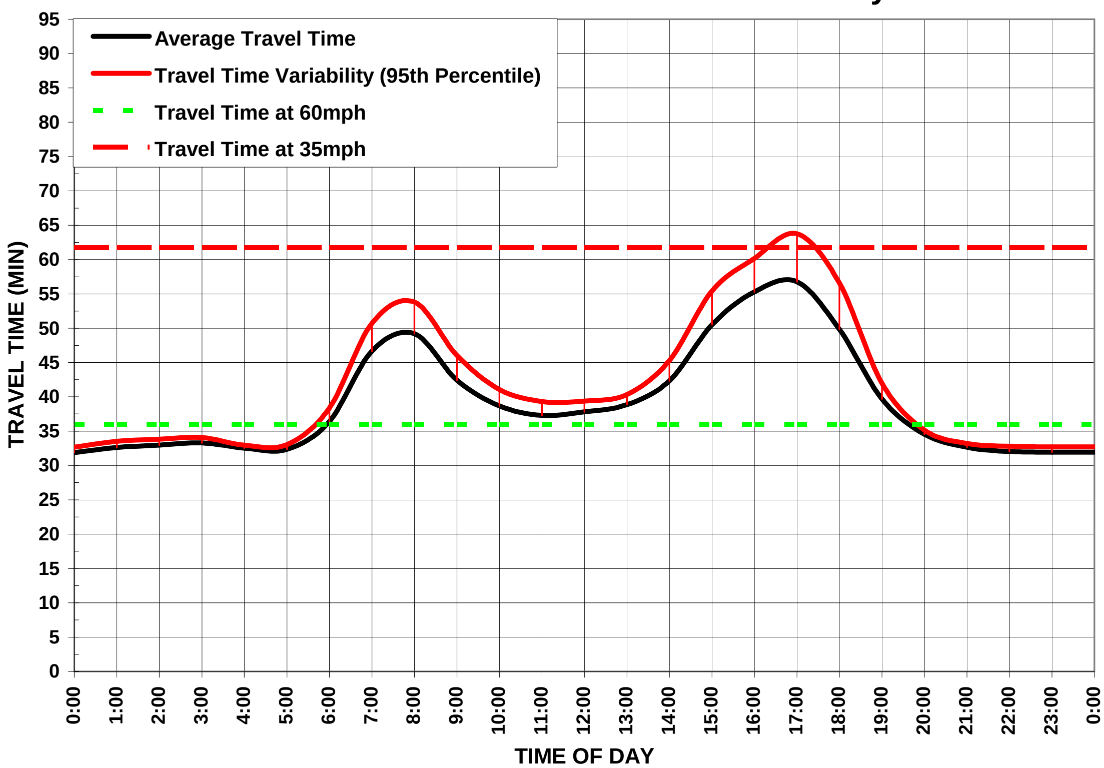


Exhibit 3-19: Northbound Travel Time Variability 2003

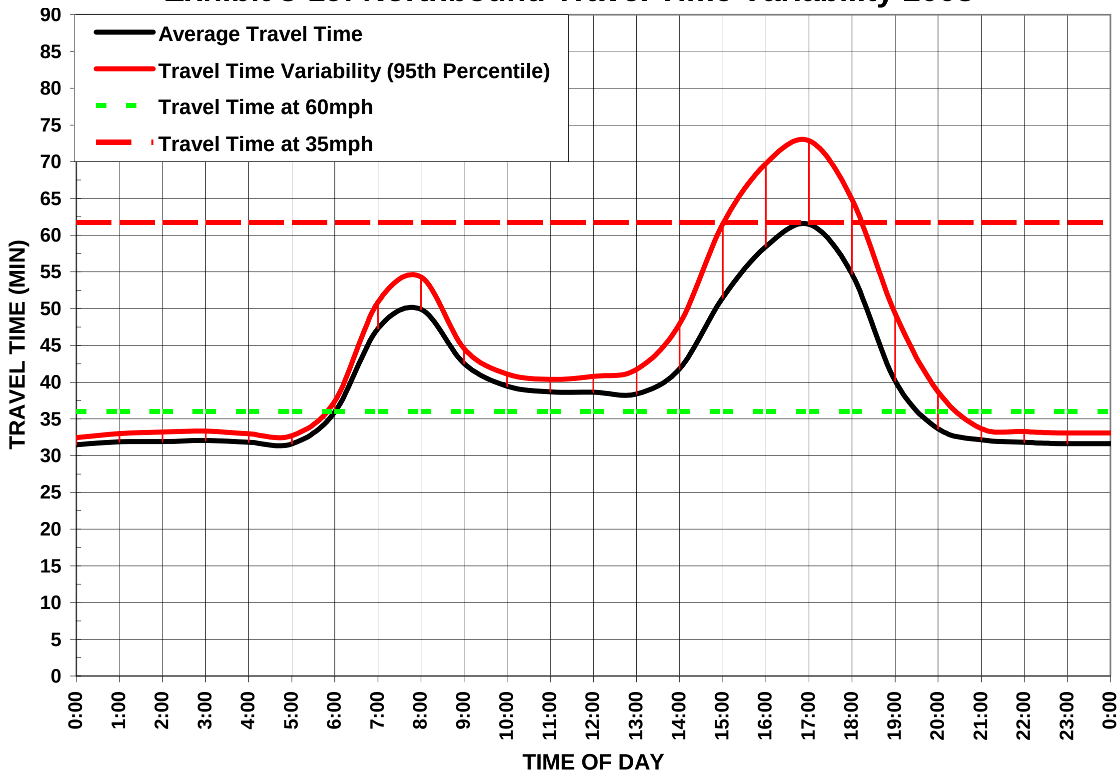
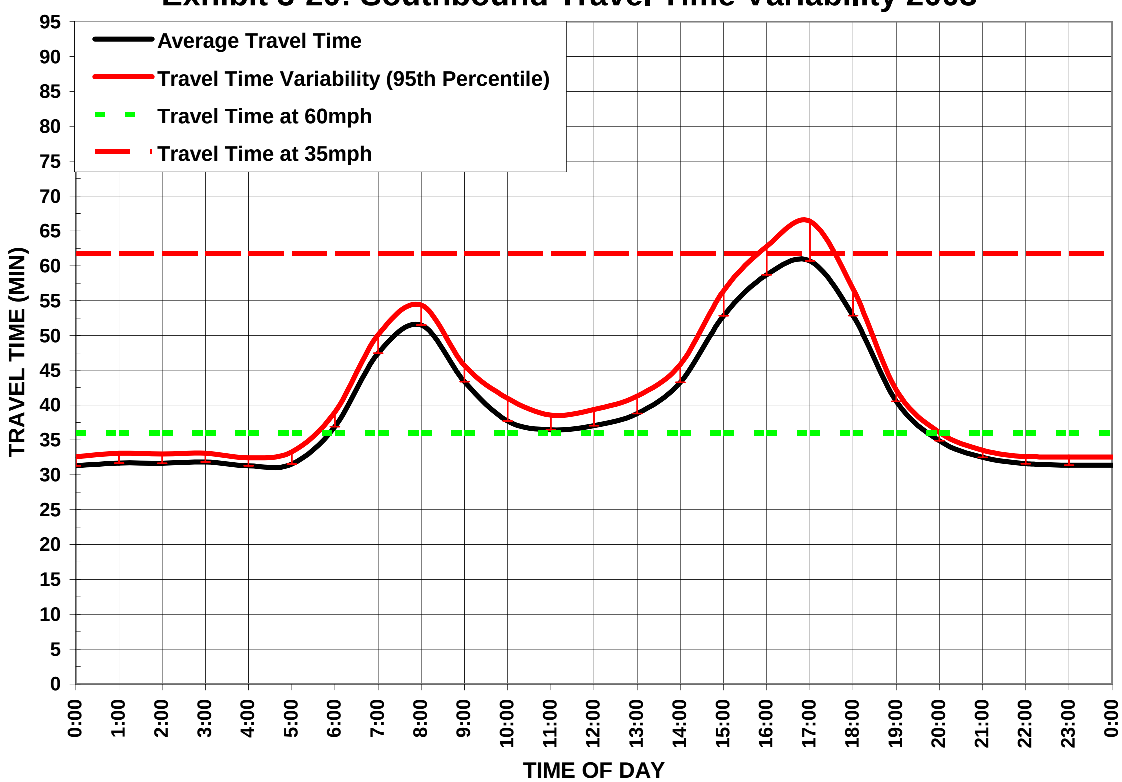


Exhibit 3-20: Southbound Travel Time Variability 2003



SAFETY

The adopted performance measures to assess safety are: the number of accidents and accident rates computed from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). TASAS is a traffic records system containing an accident database linked to a highway database. The highway database contains description elements of highway segments, intersections and ramps, access control, traffic volumes and other data. TASAS contains specific data for accidents on State highways. Accidents on non-State highways are not included (e.g., local streets and roads).

The safety assessment in this report is intended to characterize the overall accident history and trends in the corridor, and to highlight notable accident concentration locations or patterns that are readily apparent. This report is not intended to supplant more detailed safety investigations routinely performed by Caltrans staff.

Exhibits 3-21 and 3-22 illustrate the I-405 northbound and southbound accidents by month, respectively. Caltrans typically analyzes the latest three-year safety data. The latest available data from July 1, 2003 through June 30, 2006 were analyzed and summarized. Note that these are comprehensive and do not rely on automatic detection systems. As indicated, the northbound corridor experienced slightly fewer collisions than southbound. Approximately 170 collisions occurred each month in the northbound direction, as opposed to over 200 collisions that occurred each month in the southbound direction. In each direction, there is a downward trend in total number of accidents starting in 2005.

Exhibit 3-21: Northbound Monthly Accidents 2003-2006

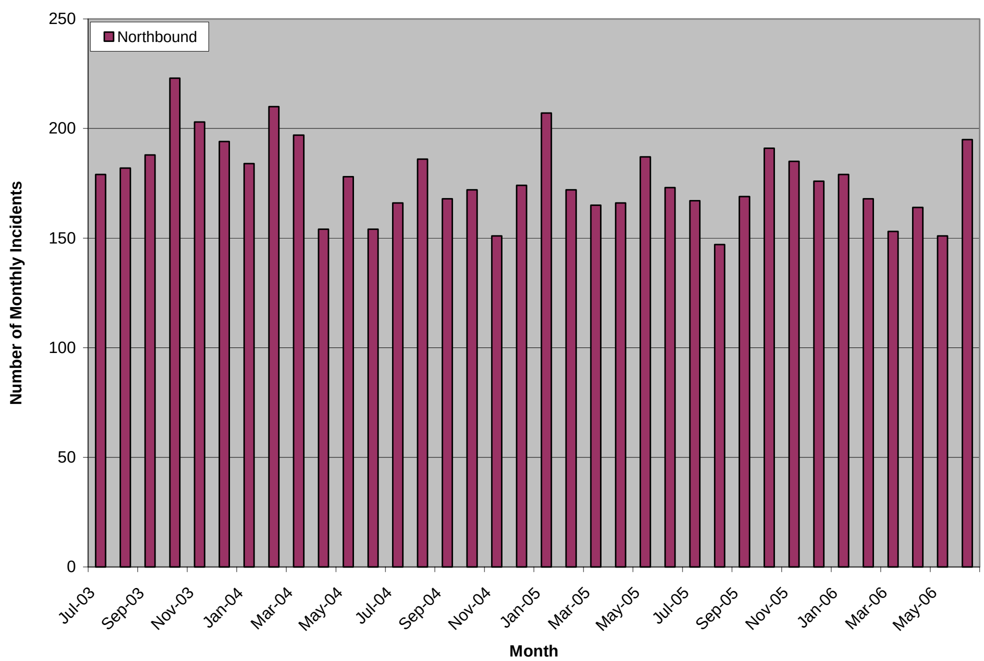


Exhibit 3-22: Southbound Monthly Accidents 2003-2006

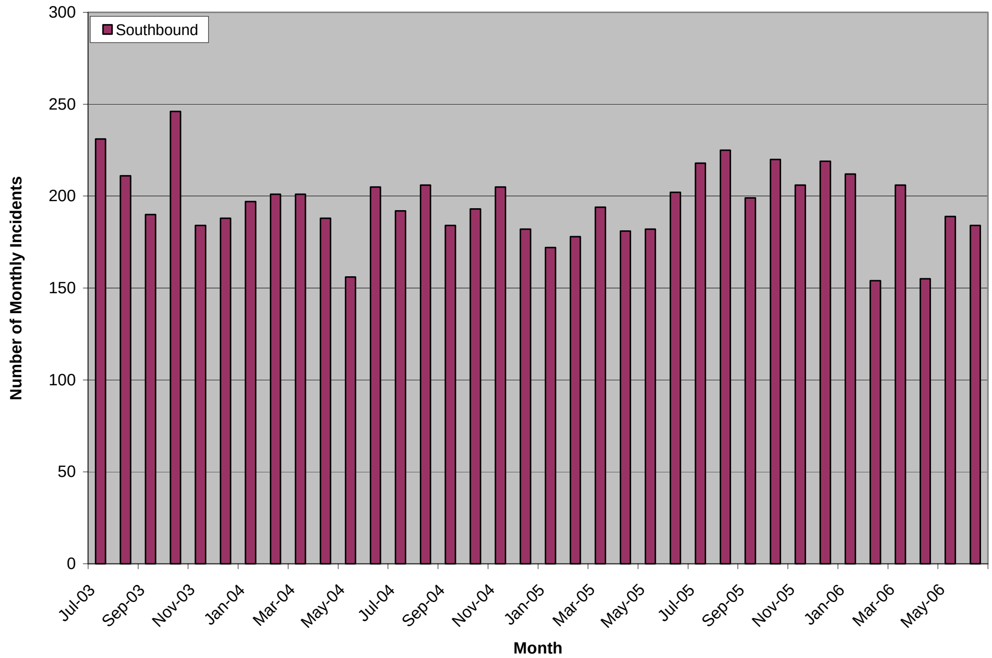


Exhibit 3-23 presents the latest TASAS three year accident data for April 1, 2004 through March 31, 2007 for the I-405 corridor. Total number of accidents by type (fatality, injury, and property damage only (PDO), vehicle miles of travel, and the accident rate by type are provided. As indicated in this exhibit, the I-405 corridor experienced lower accident rates in both fatalities and injuries as compared to the average rates experienced by similar roadway facilities.

Exhibit 3-23: Total Number of Accidents by Type and Accident Rate (2004-2007)

		Number of Accidents on I-405					Accident Rates					
							Actual Rates on I-405			Average Rates on Similar Facilities		
From	*To*	*Fat*	*Inj*	*PDO*	*Total*	*MVM*	*Fat*	*F+I*	*Total*	*Fat*	*F+I*	*Total*
Northbound												
I-110 (Harbor Freeway)	I-5 (Golden State Freeway)	12	1561	3708	5281	5110.89	0.002	0.31	1.03	0.006	0.36	1.16
Southbound												
I-5 (Golden State Freeway)	I-110 (Harbor Freeway)	11	1804	4056	5871	5110.89	0.002	0.36	1.15	0.006	0.36	1.16

Note: Accident rates expressed as # of accidents/Million Vehicle Miles (MVM)

PRODUCTIVITY

Productivity is a system efficiency measure used to analyze the capacity of the corridor, and is defined as the ratio of output (or service) per unit of input. In the case of transportation, it is the amount of people served divided by the level of service provided. Specific to highways, the input to the system is the capacity of the roadways; in transit, it is the number seats provided. For corridor analyses, productivity is defined as the percent utilization of a facility or mode under peak conditions. The highway productivity performance measure is calculated as actual volume divided by the capacity of the highway. Travel demand models do not generally project capacity loss for highways, but detailed micro-simulation tools can forecast productivity.

For highways, productivity is particularly important because where capacity is needed the most, the lowest “production” from the transportation system often occurs.

This loss in productivity example is illustrated in Exhibit 3-24. As traffic flow increase to the capacity limits of a roadway, speeds decline rapidly and throughput drops dramatically. This loss in throughput is the lost productivity of the system. There are a few ways to estimate productivity losses. Regardless of the approach, productivity calculations require good detection or significant field data collection at congested locations. One approach is to convert this lost productivity into “equivalent lost lane-miles.” These lost lane-miles represent a theoretical level of capacity that would have to be added in order to achieve maximum productivity. For example, losing six lane-miles implies that adding a new lane along a six-mile section of freeway would improve productivity. Equivalent lost lane-miles is computed as follows (for congested locations only):

$$LostLaneMiles = \left(1 - \frac{ObservedLaneThroughput}{2000vphpl}\right) \times Lanes \times LengthofCongestedSegment$$

Exhibit 3-25 summarizes the productivity losses on the I-405 corridor for the three years analyzed for the respective directions of travel. As indicated the largest productivity losses occurred in the PM peak hours. While the northbound had improved from 2002 to 2003 in both the AM and PM peak hours, the southbound had worsened each year from 2001 to 2003.

Exhibit 3-24: Lost Productivity Illustrated

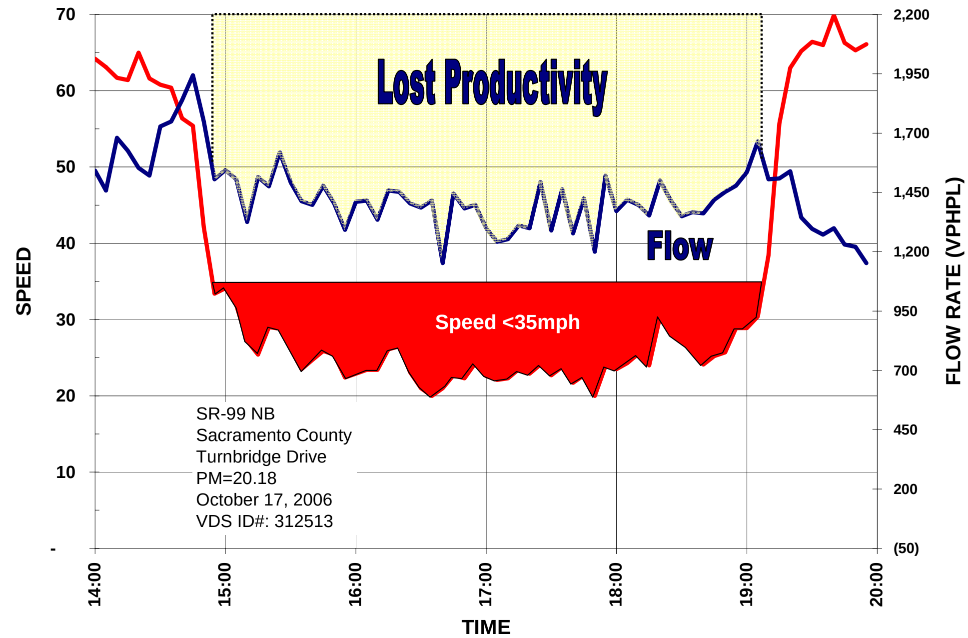
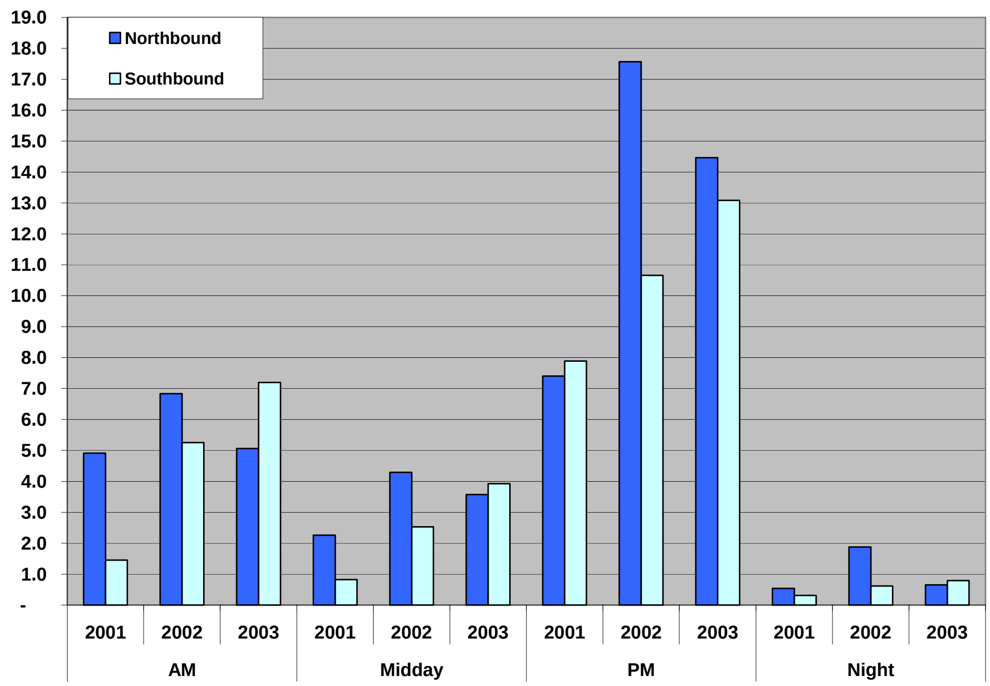


Exhibit 3-25: Average Lost Lane Miles by Direction, Time Period, and Year



4. BOTTLENECK ANALYSIS

In this section of the report, the results of the bottleneck analysis are presented. The bottleneck analysis was conducted to identify potential bottleneck locations. Potential freeway bottleneck locations that create mobility constraints are identified and documented, and their relative contribution to corridor-wide congestion is reported. A variety of sources were used to identify bottlenecks. They include the following:

- Caltrans Highway Congestion Monitoring Program (HICOMP) 2006 report;
- Probe vehicle runs (electronic tach runs)
- Freeway Performance Measurement System (PeMS)
- Aerial photos (Google Earth) and Caltrans photologs
- Field observations

Exhibit 4-1 provides a summary of the bottlenecks identified from the analysis of the various sources. Each bottleneck was verified in separate field observations made on a normal weekday in November and December 2007 and February 2008. The rows in bold represent bottlenecks that have been verified by multiple sources and are most likely recurrent bottlenecks that exist today. The others should be revisited and verified when more data becomes available.

Exhibit 4-1: Summary of Bottlenecks Identified and Verified

BOTTLENECK LOCATION	**HICOMP** [a] **Report**		**Caltrans** [b] **Probe Veh. Runs**		**PeMS** [c] **Speed Contours**	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**
NORTHBOUND						
Normandie off	-	-	-	✓	✓	✓
Crenshaw off	-	-	-	✓	✓	✓
Hawthorne on	-	-	✓	-	✓	-
Inglewood on to Rosecrans off	✓	-	-	-	✓	-
La Tijera/Hughes on to Sepulveda	-	-	-	-	✓	✓
Culver on	✓	-	✓	-	✓	✓
Wilshire on	-	-	-	-	-	✓
Getty on	-	✓	-	-	-	✓
Mulholland Drive	-	✓	-	-	-	✓
US-101 off	-	-	✓	✓	-	✓
Victory on	-	-	-	✓	-	✓
Nordhoff on	-	✓	-	✓	-	-
SOUTHBOUND						
Devonshire on	-	-	✓	-	✓	-
Victory on	-	-	✓	-	✓	-
US-101 on	✓	-	-	-	-	-
Montana on	✓	-	-	-	-	-
Sunset on	-	-	-	-	✓	-
Wilshire off	-	-	-	✓	✓	-
I-10 on	-	✓	-	-	-	-
Culver on	-	-	✓	✓	✓	✓
La Tijera/Hughes Pkwy off	-	-	-	✓	✓	✓
El Segundo on to Rosecrans off	✓	✓	-	✓	✓	✓
Inglewood	-	-	-	-	✓	✓
Crenshaw on	-	-	✓	✓	-	-
I-110 off/on	-	✓	-	-	✓	✓

NOTES:
[a] Based on 2006 HICOMP report.
[b] Based on Caltrans District 7 sample probe vehicle runs, taken in March/April 2002 and 2003.
[c] Based on Performance Measurement System (PeMS) sample daily speed contours taken from April & October 2003, and 2003 quarterly weekday averages.
- No indication of bottleneck from this source.
✓ Bottleneck identified from this source.

ANALYSIS DETAILS

HICOMP

In review of the Caltrans Highway Congestion Monitoring (HICOMP) 2006 report, potential problem areas are initially identified. As illustrated in Exhibits 4-2 and 4-3, the downstream end of congested segments could potentially be bottleneck areas in the southbound direction, as outlined in blue circles, and in the northbound direction, as outlined in red circles.

- As indicated, in the **AM peak** there are potentially two major bottlenecks in the northbound direction and three major bottlenecks in the southbound direction, as identified in the 2006 HICOMP:
  - Rosecrans Avenue (NB)
  - 135th Street, south of El Segundo Boulevard (SB)
  - Culver Boulevard (NB)
  - Montana Avenue (SB)
  - US-101 Interchange (SB)
- In the **PM peak**, there are potentially three major bottlenecks in the northbound direction and three in the southbound direction:
  - Van Ness Avenue/I-110 Interchange (SB)
  - Rosecrans Avenue (SB)
  - Ballona Creek, south of Culver Boulevard (SB)
  - Getty Center Drive (NB)
  - Mulholland Drive (NB)
  - Lassen Street, north of Nordhoff Street (NB)

Further analysis would be needed, however, to determine their actual locations and possibly any other bottlenecks along the corridor not identified in the HICOMP. The review of the HICOMP provides a good starting point to keep in mind of the congested areas and possible bottleneck locations as more detailed analysis is conducted.

Exhibit 4-2: 2006 HICOMP AM Congestion Map with Potential Bottlenecks

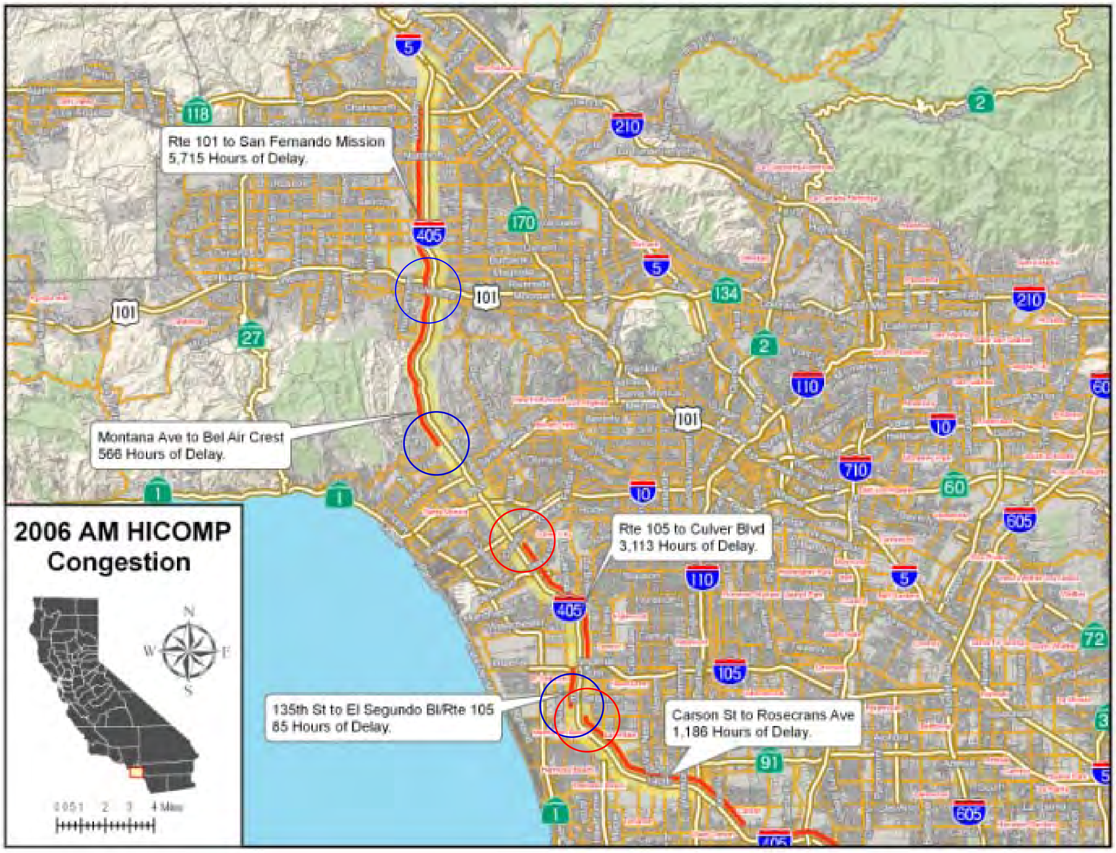
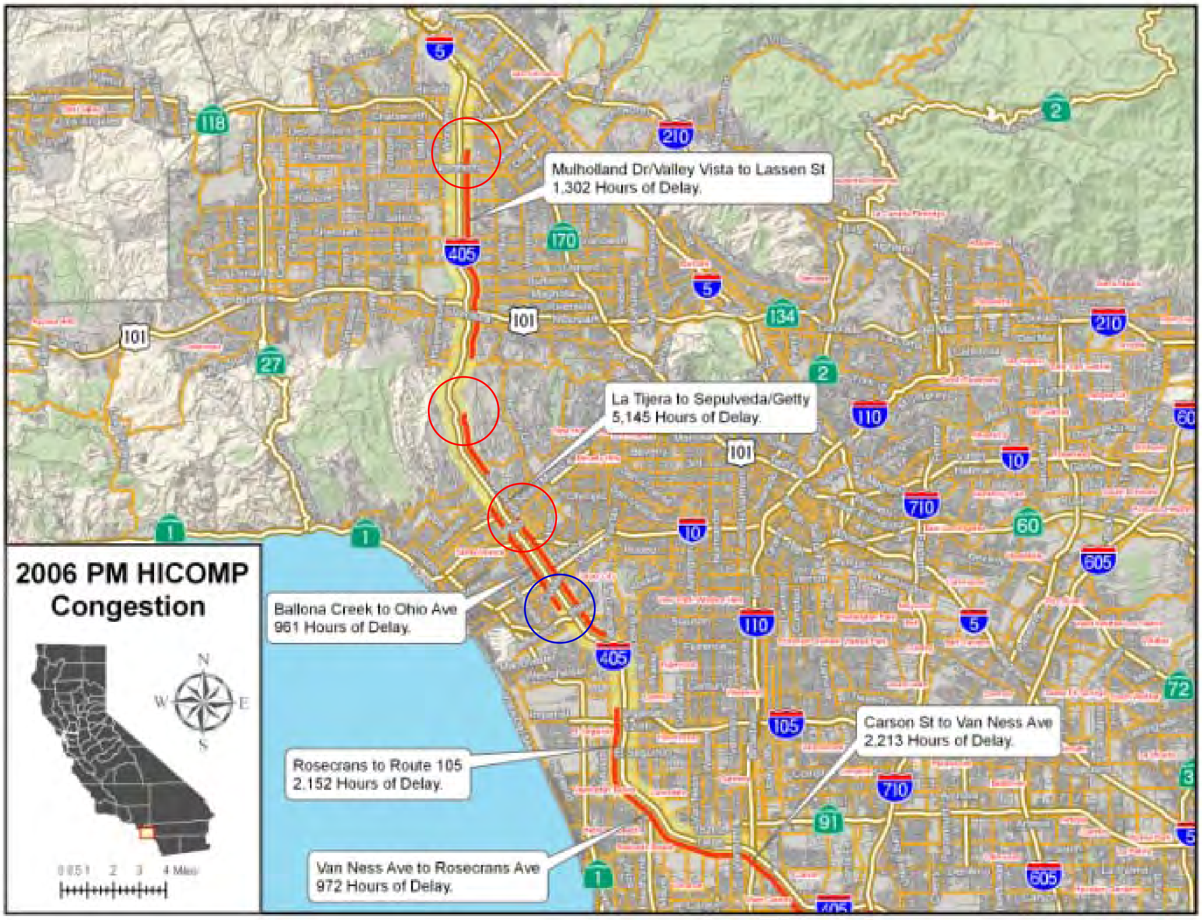


Exhibit 4-3: 2006 HICOMP PM Congestion Map with Potential Bottlenecks



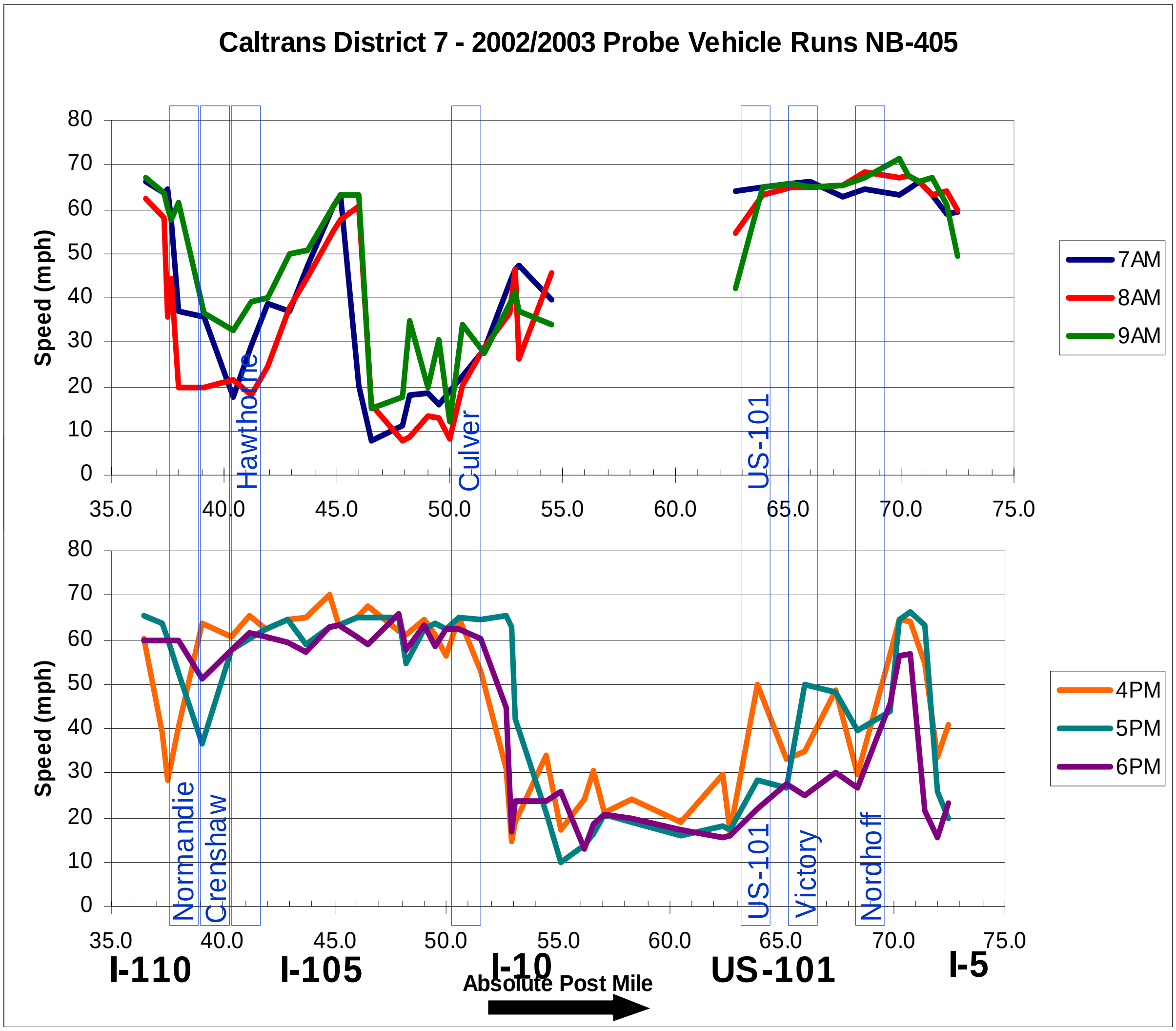
Probe Vehicle Runs

The probe vehicle runs (electronic tach runs) provide speed plots across the corridor at various departure times. A vehicle equipped with an electronic (GPS or tachograph) device is driven along the corridor at various departure times, typically in a middle lane, during the peak period, at regular, 20 to 30 minute intervals. Actual speeds are recorded as the vehicle traverses the corridor length. Bottlenecks can be found at the end of a slow congested speed location where speeds pick up to 30 miles per hour to 50 miles per hour.

Caltrans District 7 collected probe vehicle run data in March and April 2002 and March 2003, their most recent data available, for the I-405 freeway from I-605 junction to the I-5 junction. The freeway corridor runs were broken into five separate segments from I-605 to I-110, I-110 to I-105, I-105 to I-10, I-10 to US-101, and US-101 to I-5. For each segment, the runs were conducted from approximately 6AM to 10AM and from 2:30PM to 7:30PM, except for Segment 3 (I-10 to US-101), which did not include AM runs.

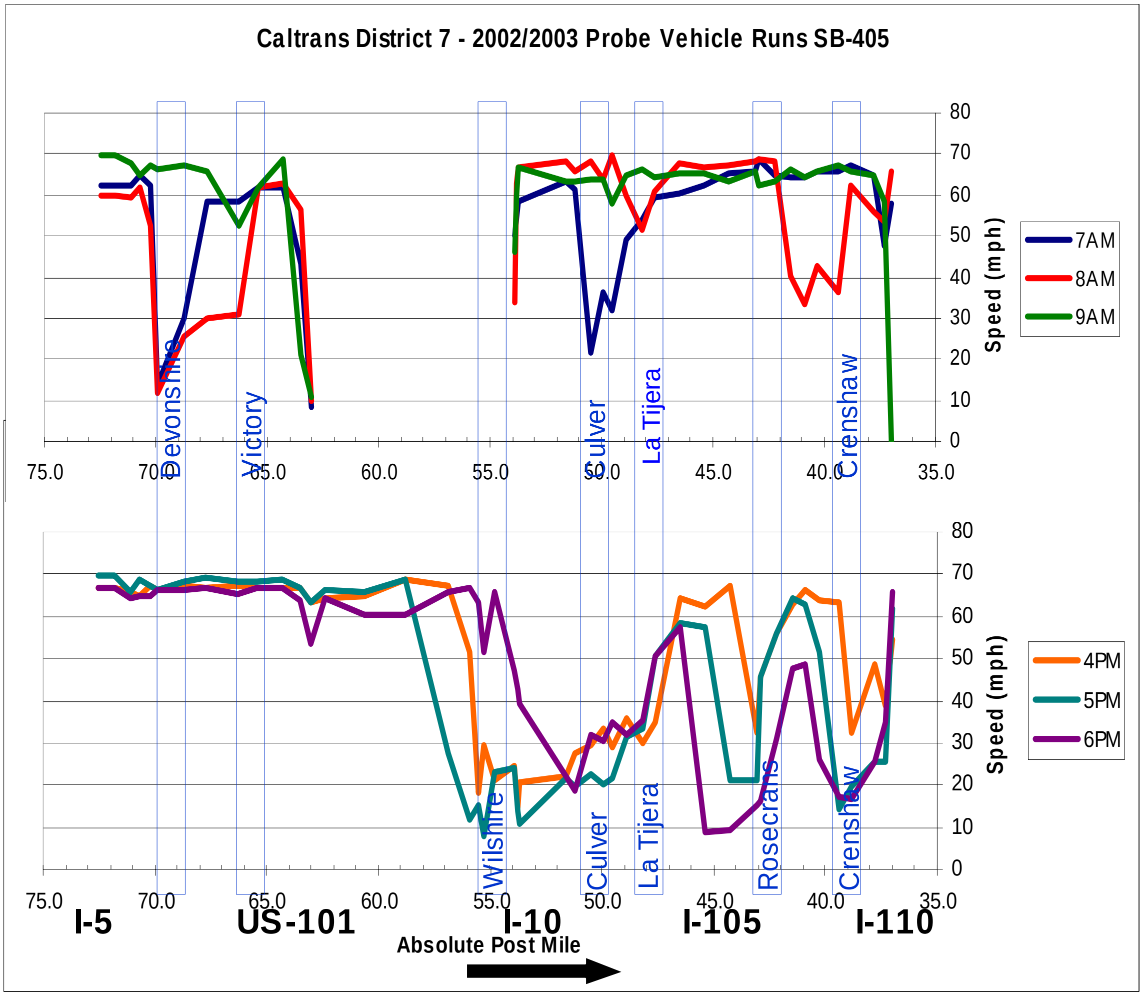
Exhibit 4-4 illustrates the compiled northbound probe vehicle runs and Exhibit 4-5 illustrates the compiled southbound probe vehicle runs at 7AM, 8AM, 9AM, 4PM, 5PM, and 6PM.

Exhibit 4-4: Northbound I-405 Probe Vehicle Runs



- As indicated, major <u>northbound</u> bottlenecks from the probe vehicle runs were identified at:
    - Normandie Avenue off (PM)
    - Crenshaw Boulevard off (PM)
    - Hawthorne Boulevard on (AM)
    - Culver Boulevard on (AM)
    - US-101 off (AM/PM)
    - Victory Boulevard on (PM)
    - Nordhoff Street on (PM)

Exhibit 4-5: Southbound I-405 Probe Vehicle Runs



- As indicated, major <u>southbound</u> bottlenecks from the probe vehicle runs were identified at:
    - o Devonshire Street on (AM)
    - o Victory Boulevard on (AM)
    - o Wilshire Boulevard off (PM)
    - o Culver Boulevard on (AM/PM)
    - o La Tijera Boulevard off (AM/PM)
    - o Rosecrans Avenue off (PM)
    - o Crenshaw Boulevard on (AM/PM)

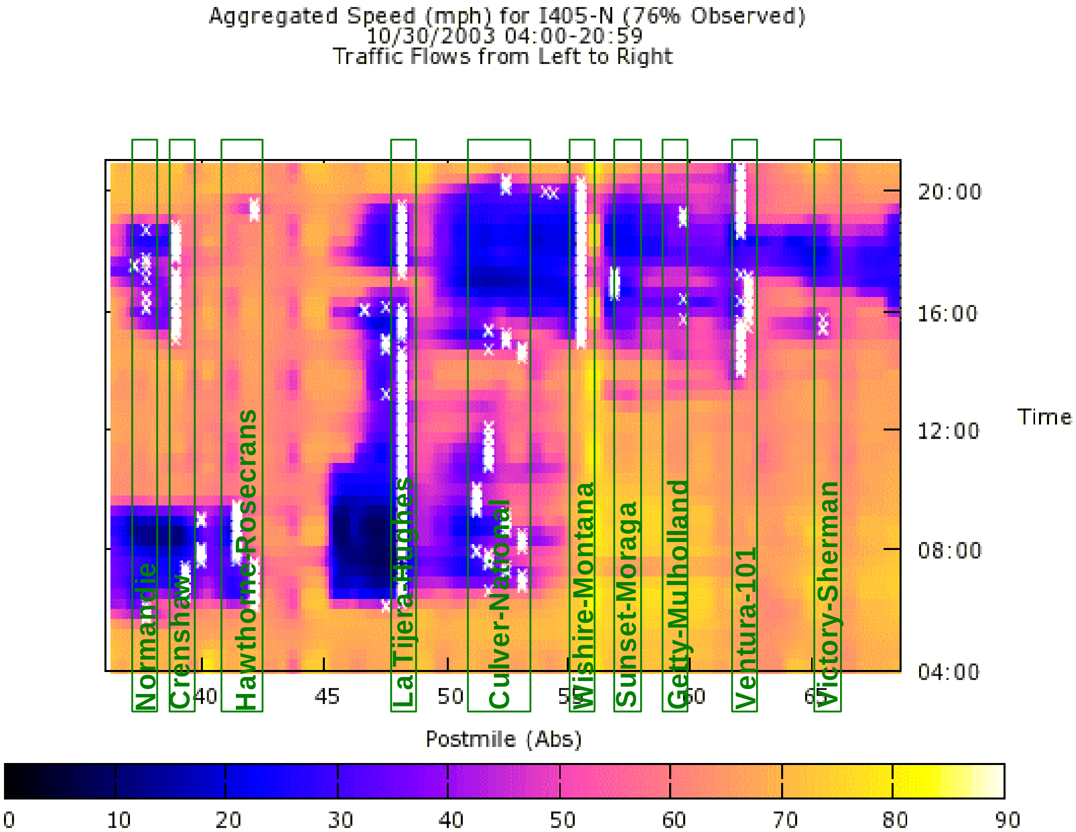
Freeway Performance Measurement System (PeMS)

In PeMS, speed plots are also used to identify potential bottleneck locations. Speed plots are very similar to probe vehicle run graphs. Unlike the probe vehicle runs, however, each speed plot has universally the same time across the corridor. For example, an 8AM plot includes the speed at one end of the corridor at 8AM and the speed at the other end of the corridor also at 8AM. With probe vehicle runs, the end time, or time at the end of the corridor is the departure time plus the actual travel time. Despite this difference, they both identify the same problem areas. These speed plots are then compiled at every five minutes and presented in speed contour plots.

NORTHBOUND

Exhibit 4-6 illustrates the speed contour plot on Thursday, October 30, 2003. The speed contour plot represents a typical weekday sample to illustrate the bottleneck locations and congestion formed from them. The sample day had observed or “good” detection data of 76%, providing reasonably accurate results. The speed contour plot illustrates the typical speed contour diagram for the I-405 freeway in the northbound direction (traffic moving left to right on the plot). Along the vertical axis is the time period from 4AM to 8PM. Along the horizontal axis is the corridor segment from south of I-110 to I-5. The various colors represent the average speeds corresponding to the color speed chart shown below the diagram. As shown, the dark blue blotches represent congested areas where speeds are reduced. The ends of each dark blotch represent bottleneck areas, where speeds pickup after congestion, typically to 30 to 50 miles per hour in a relatively short distance. The horizontal length of each plot is the congested segment, queue lengths. The vertical length is the congested time period.

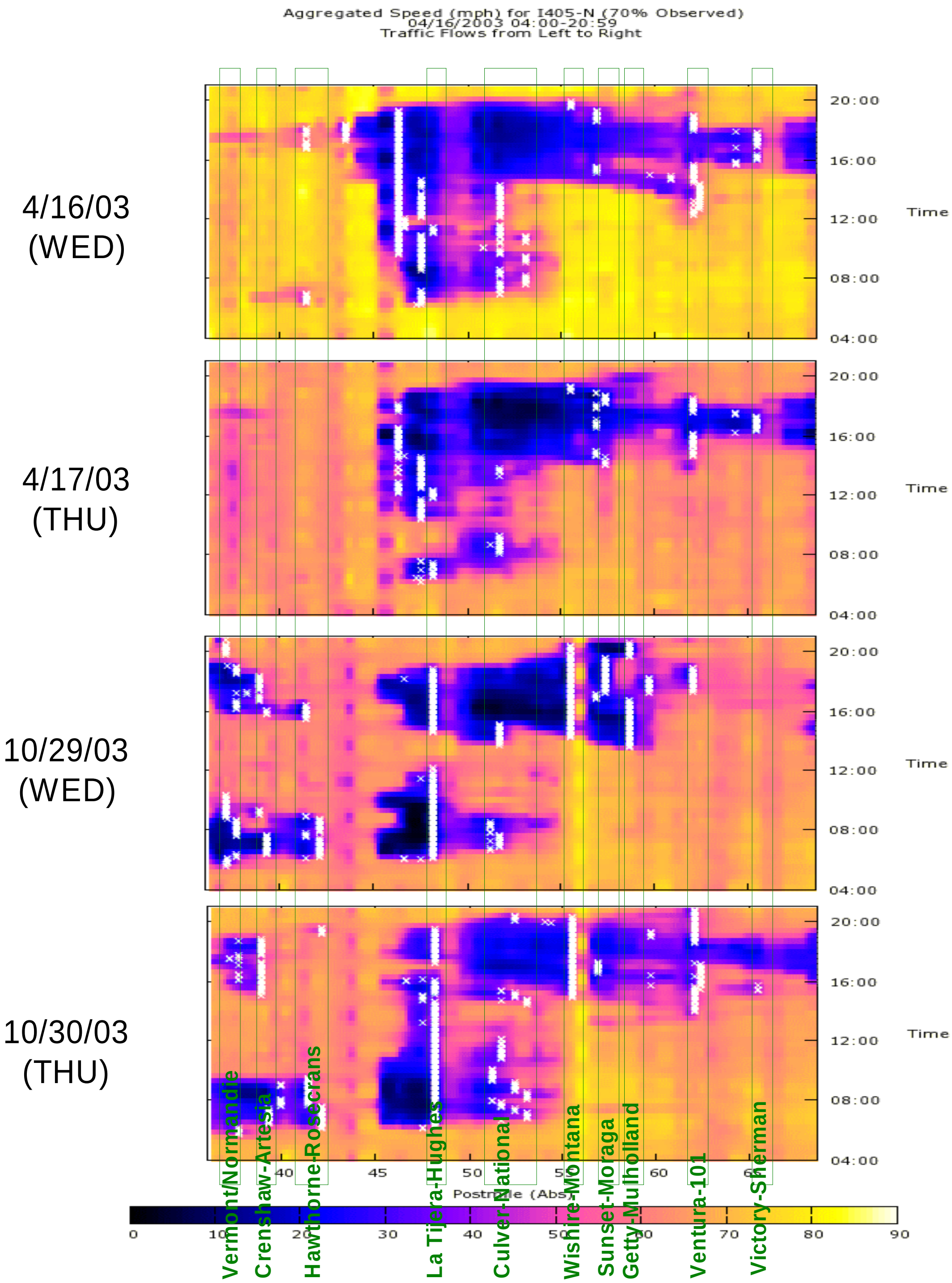
Exhibit 4-6: PeMS Northbound I-405 Speed Contour Plot – October 2003



- Based on the contour plot of a typical weekday sample in October 2003, the following bottlenecks were identified in the northbound direction:
  - Normandie Avenue off (AM/PM)
  - Crenshaw Boulevard off (AM/PM)
  - Hawthorne Boulevard on (AM)
  - Rosecrans Avenue off (AM)
  - Howard Hughes Parkway on (AM/PM)
  - Various from Culver Boulevard to National Boulevard (AM/PM)
  - Wilshire Boulevard on (PM)
  - Sunset Boulevard on (PM)
  - Getty Center Drive to Mulholland Drive (PM)
  - US-101 off (PM)
  - Victory Boulevard on (PM)

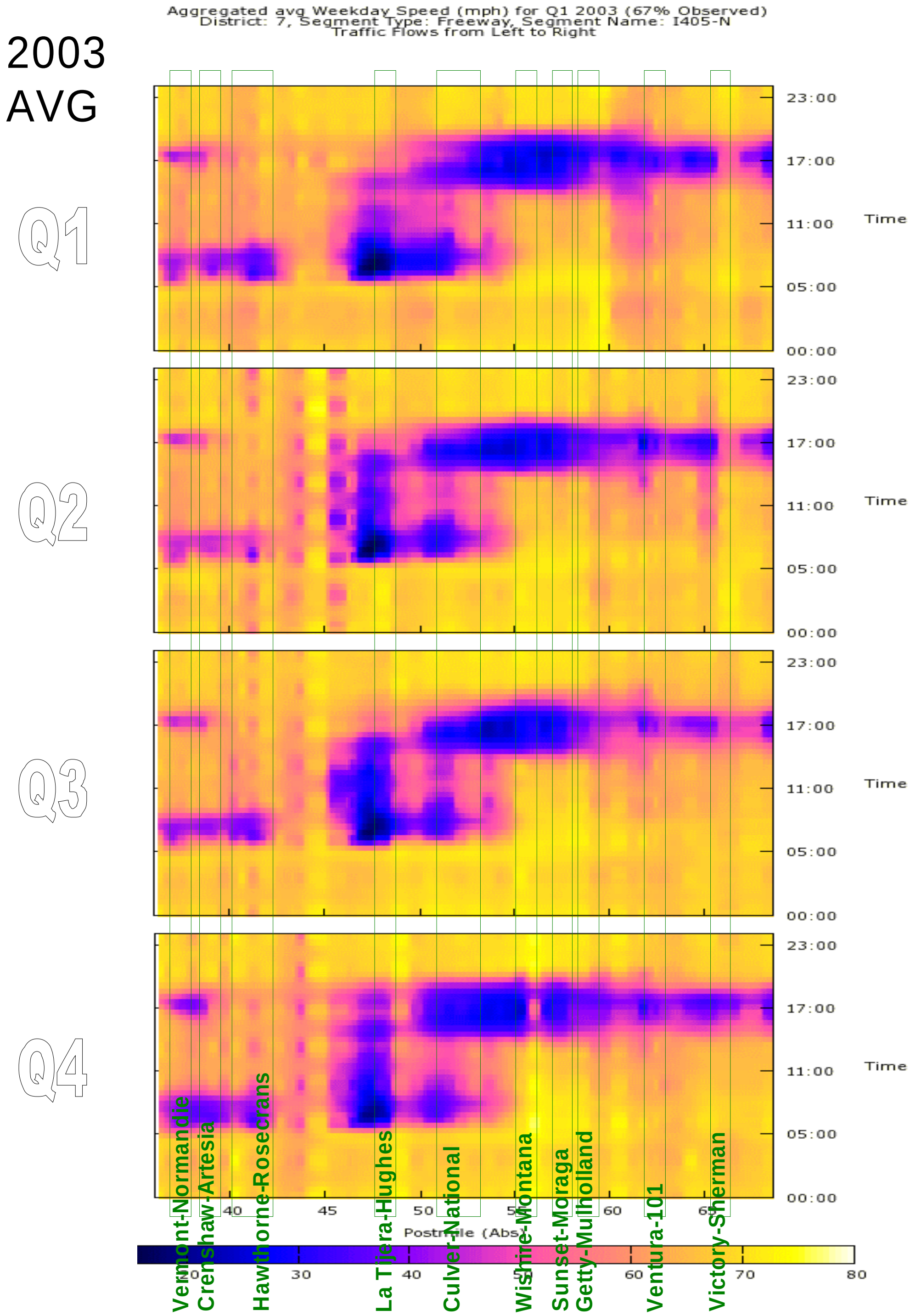
In addition to a sample day in 2003, additional sample days were also analyzed. Exhibit 4-7 illustrates the speed contours of additional weekday samples in April and October 2003. The same bottleneck locations are identified on each of the four different sample days, indicating a reoccurring pattern of the bottleneck locations.

Exhibit 4-7: PeMS Northbound I-405 Speed Contour Plots – April/October 2003



In addition to multiple days, larger averages were also analyzed. Exhibit 4-8 illustrates the weekday averages by each quarter of 2003. Again, the same bottleneck locations are identified. From the long contours, the same bottlenecks are evident, further validating the reoccurring pattern of the bottleneck locations.

Exhibit 4-8: PeMS Northbound I-405 Long (Speed) Contours – 2003 by Qtr Avg



<u>SOUTHBOUND</u>

Similarly, speed contour plots for the same sample days and 2003 quarterly weekday average long contours were analyzed for the southbound direction. Exhibits 4-9 to 4-11 illustrate the speed contour plots for the I-405 freeway corridor in the southbound direction (traffic moving left to right on the plot) for a sample weekday in October 2003, four typical weekdays in April and October 2003, and 2003 quarterly weekday average long contours. Along the vertical axis is the time period from 4AM to 8PM. Along the horizontal axis is the corridor segment from south of I-110 to I-5. Similar to the northbound PeMS speed contour analysis results, the PeMS southbound speed contour analysis results indicate reoccurring bottleneck locations across multiple weekdays and quarterly averages.

- Based on these contour plots of typical weekday samples in April and October 2003 and quarterly averages of weekdays, the following bottlenecks were identified in the <u>southbound</u> direction:
  - I-110 (PM)
  - Inglewood Avenue off (AM/PM)
  - El Segundo Boulevard on to Rosecrans Avenue off (AM/PM)
  - La Tijera Boulevard off (AM/PM)
  - Culver Boulevard on (AM/PM)
  - Wilshire Boulevard off (AM)
  - Sunset Boulevard on (AM)
  - Victory Boulevard on (AM)
  - Devonshire Street on to Nordhoff Street off (AM)

Exhibit 4-9: PeMS Southbound I-405 Speed Contour Plot – October 2003

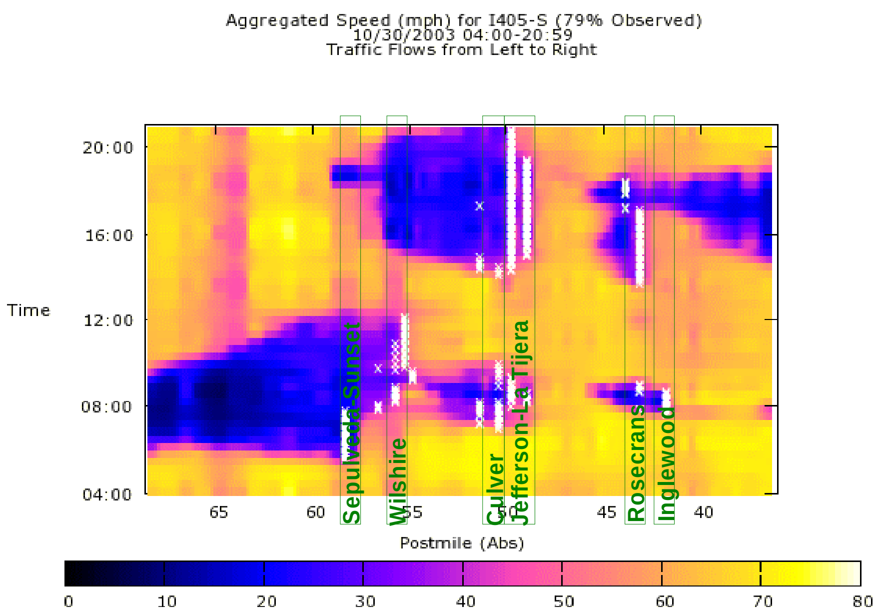


Exhibit 4-10: PeMS Southbound I-405 Speed Contour Plots – April/October 2003

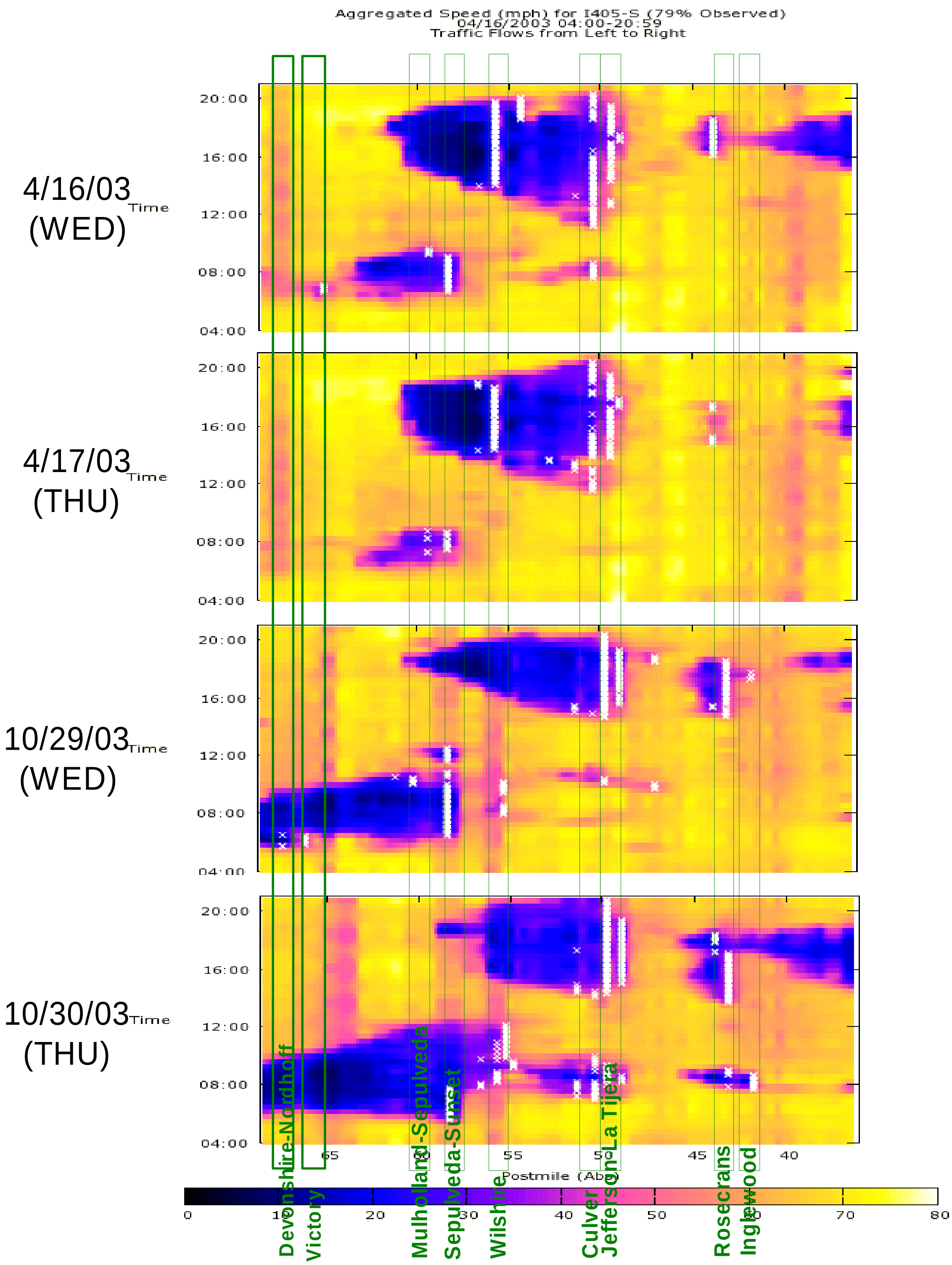
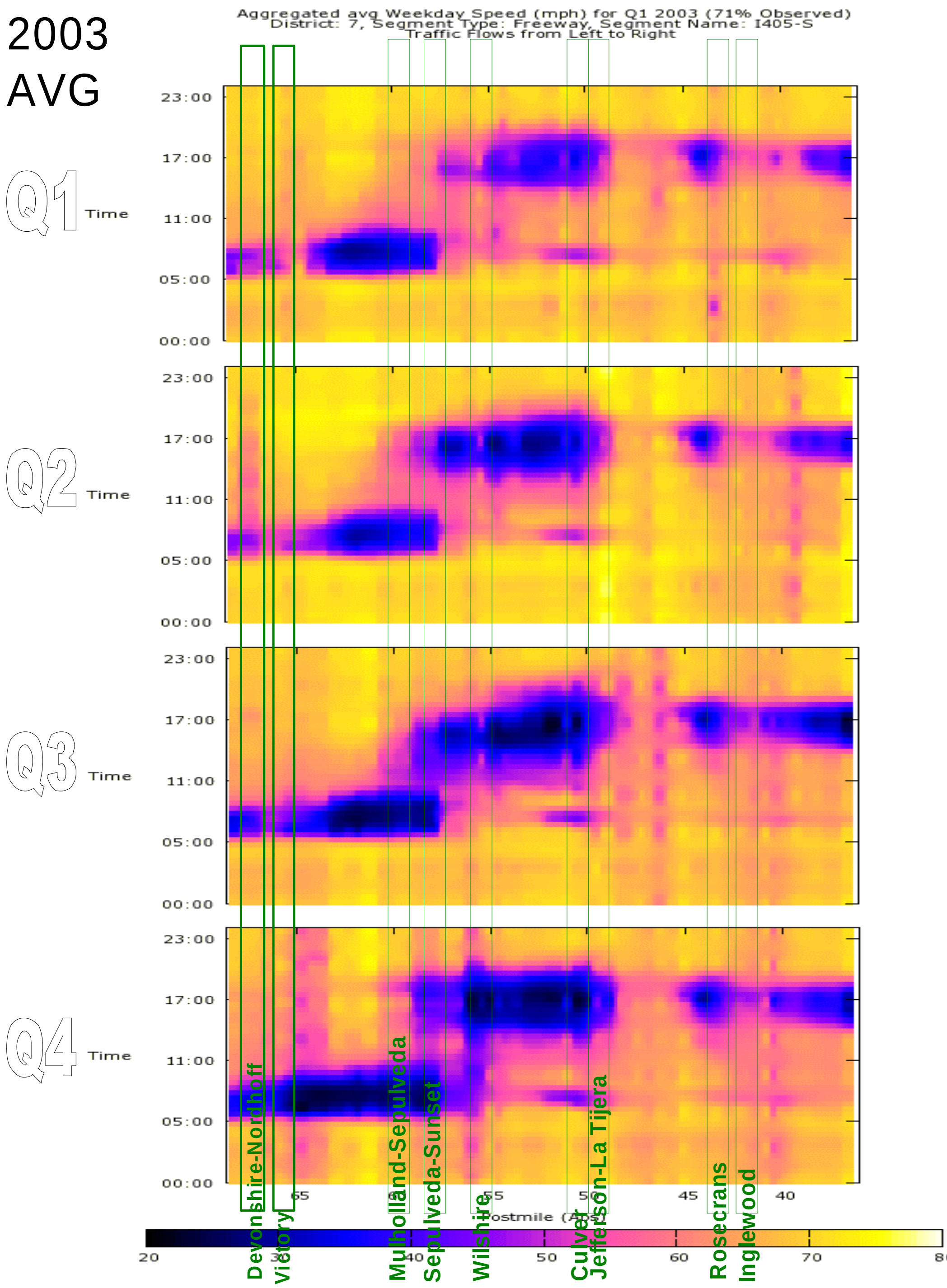


Exhibit 4-11: PeMS Southbound I-405 Long (Speed) Contours – 2003 by Qtr Avg



5. BOTTLENECK CAUSALITY

Simply stated, by definition, a bottleneck is a condition where traffic demand exceeds the capacity of the roadway facility. The cause in most cases is either a sudden reduction in capacity for various reasons, such as roadway geometry, heavy merging and weaving, and driver distractions, or a surge in demand that the facility cannot accommodate. In many cases, it is a combination of demand increases and capacity reductions. Below is a summary of the causes of the bottleneck locations.

NORTHBOUND BOTTLENECKS AND THEIR CAUSES

Vermont Avenue On to Normandie Avenue Off

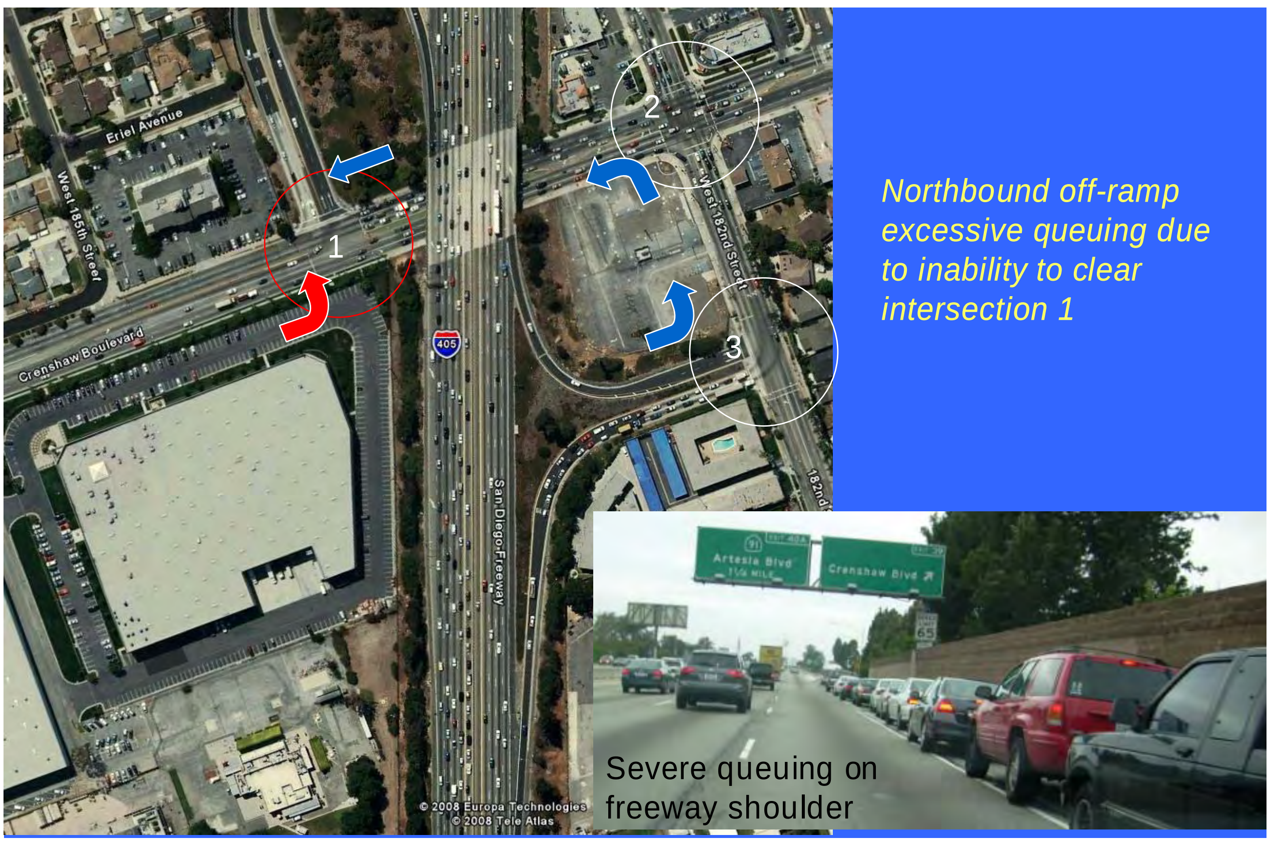
Exhibit 5-1 shows the aerial photograph of the northbound I-405 mainline from Vermont Avenue on-ramp to Normandie Avenue off-ramp. As shown, the mainline fifth lane carries mostly the I-110 heavy traffic onto I-405, as shown in the lower right photograph and indicated by the first blue arrow (note that the actual I-110 connector ramp is not shown on the aerial view). In addition, the Vermont Avenue on-ramp traffic merges with this lane, as indicated by the second blue arrow. With the cross weaving of the Normandie Avenue off-ramp traffic and the lane drop results in the bottleneck condition at this location. Just past the lane drop, speeds begin to pick up and vehicles begin to separate as shown in the inset photograph.

Exhibit 5-1: Northbound I-405 at Vermont Avenue On to Normandie Avenue Off

<u>Crenshaw Boulevard Off</u>

Exhibit 5-2 is an aerial photograph of the northbound I-405 mainline at Crenshaw Boulevard interchange. As shown in the photograph below, the off-ramp traffic queues onto the mainline, in this case along the mainline shoulder. The primary cause of this bottleneck is from the intersection 1, indicated on the exhibit. In order to provide left-turn access at this intersection, the heavy southbound Crenshaw Boulevard traffic cannot clear the intersection and queues back to intersection 2 and back along 182nd Street to intersection 3 and onto the freeway mainline.

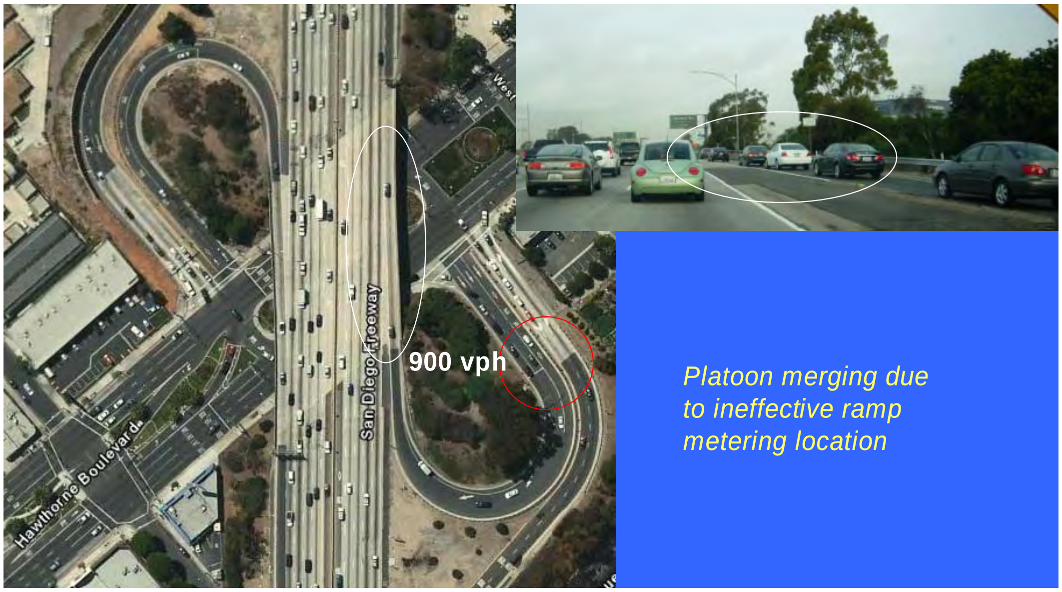
Exhibit 5-2: Northbound I-405 at Crenshaw Boulevard Off-ramp



<u>Hawthorne Boulevard On</u>

Exhibit 5-3 is an aerial photograph of the northbound I-405 at the Hawthorne Boulevard interchange. As the inset digital photograph shows, platoon of vehicles merge onto the freeway mainline, creating the bottleneck condition at this location. This is due to the ramp metering location too far back on the ramp. The slow speeds up the ramp and the merge of the three lanes into one result in the platoon of the vehicles.

Exhibit 5-3: Northbound I-405 at Hawthorne Boulevard



Inglewood Avenue/Rosecrans Avenue

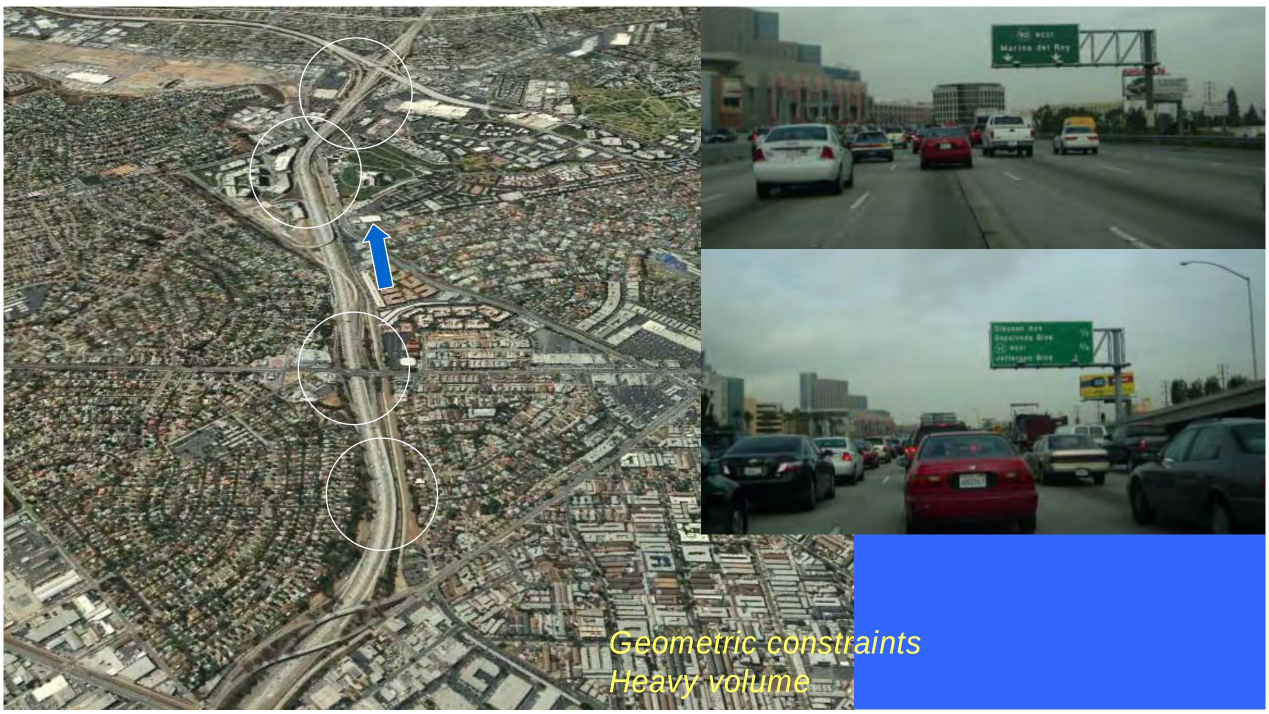
The primary cause of this bottleneck is likely due to the roadway geometry. The large horizontal curve and vertical grade reduces sight distance and affects travel speed, adversely impacting capacity. The analysis of the probe vehicle runs and PeMS speed contours indicates that the bottleneck occurs at the crest of the horizontal curve in both directions as indicated by the blue arrows and outlined by the white circles.

Exhibit 5-4: Northbound I-405 at Inglewood Avenue/Rosecrans Avenue

La Tijera Boulevard/Howard Hughes Parkway

This bottleneck location is also likely due to the roadway geometry. As indicated in the aerial photograph shown in Exhibit 5-5, an “s” curve is evident with a tight curve to the left approaching La Tijera Boulevard and to the right just past Howard Hughes Parkway, reducing sight distance and travel speeds. In addition as indicated by the inset photographs, a steady uphill grade also results in reduced speeds. During heavy traffic demand conditions in the peak hours, the adverse impact to the roadway effective capacity, however small, results in the bottleneck condition at this location.

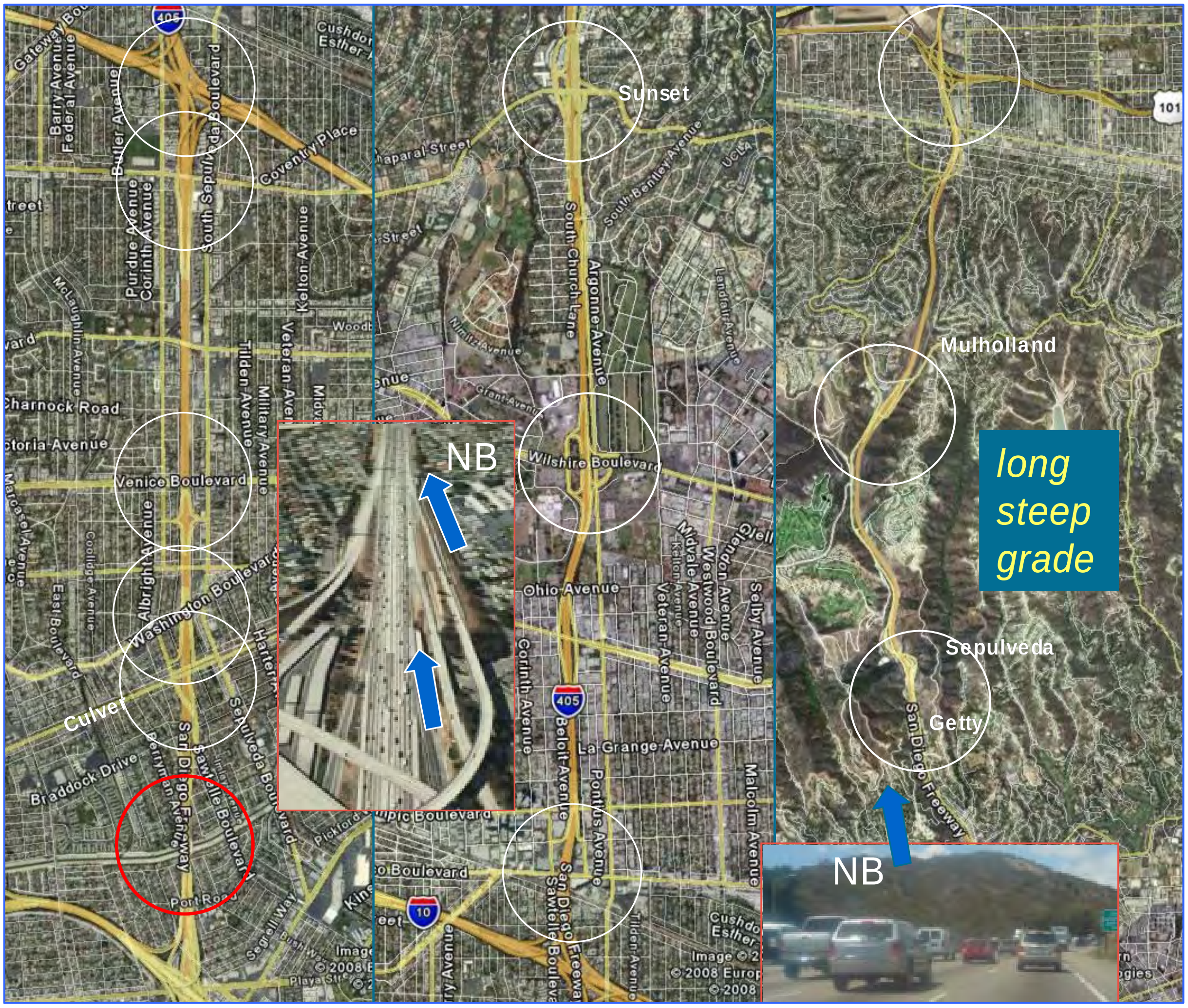
Exhibit 5-5: Northbound I-405 at La Tijera Boulevard/Howard Hughes Parkway



West Los Angeles (SR-90 to US-101)

There are multiple bottlenecks along this section of the corridor from SR-90 to the US-101 interchanges, mostly due to surge of demand from the ramps that the mainline facility cannot accommodate, particularly from SR-90 with significant traffic growth in recent years. Exhibit 5-6 shows the aerial photograph of this area with highlighted bottleneck areas by white circles. One of the more significant bottlenecks is at the Culver Boulevard approach due to the heavy traffic merging from the SR-90 on-ramps, as shown by the inset photograph. Combined, they exceed 2000 vehicles per hour during the peak hours. These ramps are currently not metered. Another significant bottleneck is at the Mulholland pass. The long steep uphill climb significantly impacts vehicle speeds reducing the effective capacity. With heavy demand, a bottleneck is formed.

Exhibit 5-6: Northbound I-405 at West Los Angeles (SR-90 to US-101)



Victory Boulevard On and Nordhoff Street On

Similar to the Hawthorne Boulevard on-ramp bottleneck, the bottleneck at the Victory Boulevard on-ramp is caused by the platoon of vehicles merging with the mainline traffic. As shown in Exhibit 5-7, the ramp metering location is too far back on the ramp. The heavy demand of the ramp traffic at over 900 vehicles per hour, long ramp distance, and slow speeds up the ramp creates the platoon of the vehicles.

At the Nordhoff Street interchange, the heavy on-ramp traffic merging onto the northbound I-405 mainline traffic is likely to cause the bottleneck condition. The on-ramp volume often exceeds 1,000 vehicles per hour during the peak hours. Currently there are two lanes metered that merges into one lane before merging with the mainline traffic.

Exhibit 5-7: Northbound I-405 at Victory Boulevard

SOUTHBOUND BOTTLENECKS AND THEIR CAUSES

Devonshire Street On to Nordhoff Street Off

Exhibit 5-8 shows the aerial photograph of the southbound (top down) I-405 at Devonshire Street. As indicated, traffic from SR-118 and two consecutive on ramps from Devonshire Street merges with the mainline traffic, while dropping a lane on the mainline approaching Nordhoff Street, creating the bottleneck condition at this location.

Exhibit 5-8: Southbound I-405 at Devonshire Street

US-101

As shown in Exhibit 5-9 inset photographs, traffic is heavily congested approaching the US-101. The primary cause of this bottleneck is the heavy traffic desiring to continue southbound on I-405 and the lane drop, lost to the US-101 connector, from 4 lanes to 3 lanes. The lower photograph shows the stream of traffic on the fourth lane that must merge to the left before the split. As shown on the upper photograph, very little of the I-405 mainline traffic is headed to the US-101 during the AM peak hours.

Exhibit 5-9: Southbound I-405 approaching US-101

Exhibit 5-10 shows the next bottleneck at the US-101 merge with the southbound I-405. The bottleneck is located at the northbound US-101 to southbound I-405 connector ramp merge point, as illustrated by the white oval. Traffic congestion from this location queues traffic back onto the US-101 mainline to the SR-134. The heavy demand from this ramp, compounded by the very tight loop of the ramp, results in a dense platoon of vehicles merging with the southbound I-405 traffic at an uphill grade, creating the bottleneck condition at this location. The lower inset photograph shows the traffic congested approaching the merge and the upper photograph showing speeds picking up and traffic beginning to separate just past the merge. This bottleneck was also observed in the field on multiple occasions during the AM peak hours. As traffic continues southward into the long steep uphill grade through Mulholland pass, more congestion is formed throughout this section of the corridor. Caltrans is currently conducting a study to reconfigure and reconstruct the southbound I-405/US-101 connectors to address some of these congestion problems.

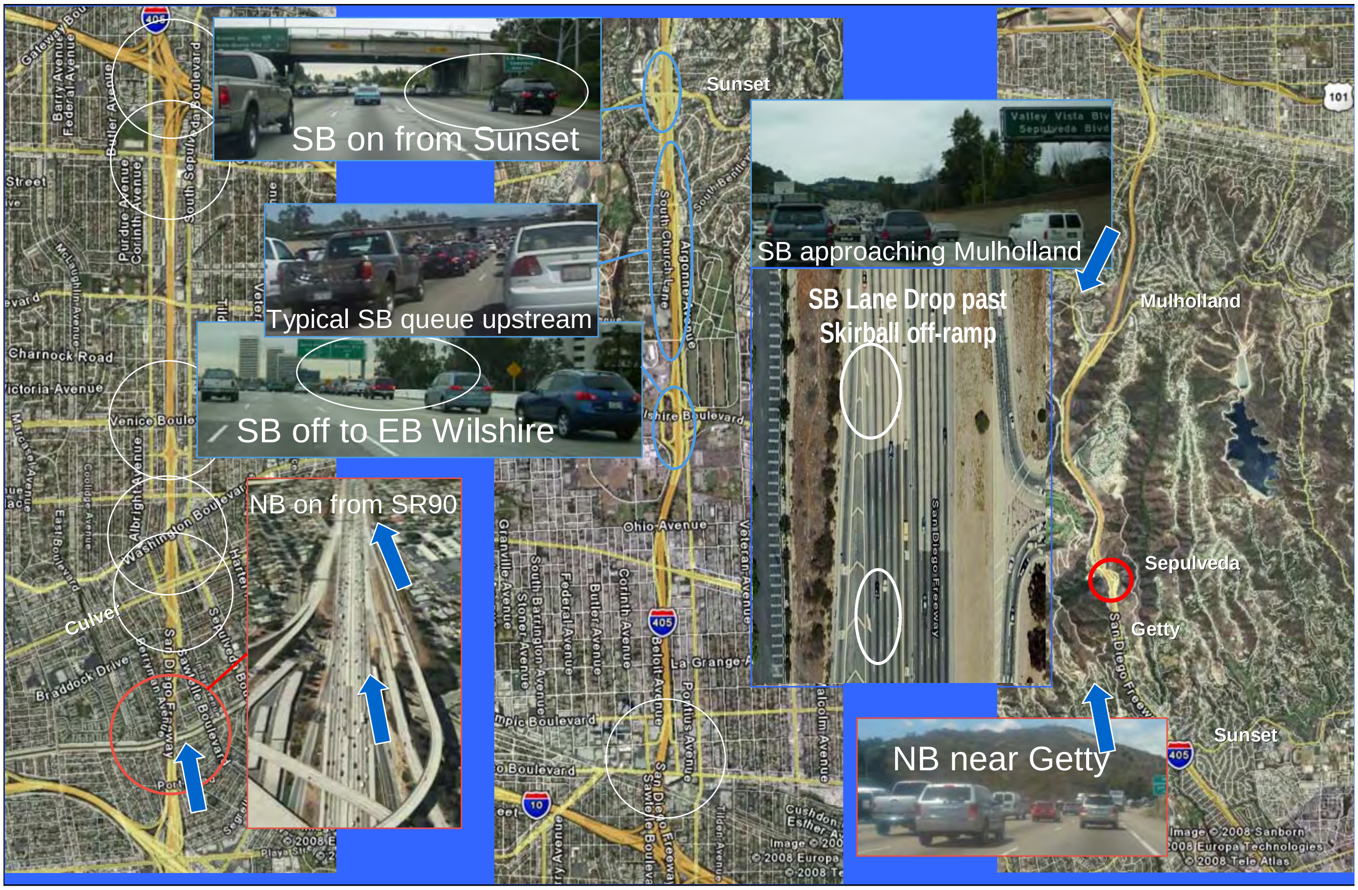
Exhibit 5-10: Southbound I-405 at US-101 merge

West Los Angeles (US-101 to SR-90)

There are multiple bottleneck locations within this section of the corridor. As traffic travels through the Mulholland pass, the steep vertical grade and the lane drop just past the Skirball off-ramp create the bottleneck condition and traffic congestion, as shown in the Exhibit 5-11 inset right photograph. For this reason, a lane gap closure from Skirball to Waterford Street is currently being considered and studied under the Sepulveda Pass Project. Another significant bottleneck is at the Sunset Boulevard on-ramp merge. This ramp is not metered. With the very short merge taper, as shown in the left above photograph in Exhibit 5-11, a small platoon of ramp traffic will cause the mainline traffic flow to breakdown, creating the bottleneck condition. Just past this location, traffic normally picks up speed to Wilshire Boulevard off-ramp, where traffic is again congested. The cause of the bottleneck at Wilshire Boulvard off-ramp is the off-ramp traffic backing up onto the mainline, as shown in the lower photograph, highlighted by the white oval. During the PM peak hours, traffic along Wilshire Boulevard is heavily congested, resulting in the queuing to the freeway mainline.

Traveling past the I-10 interchange, multiple bottlenecks are evident from National Boulevard to the Culver Boulevard, due to on-ramp ramps merging into heavy traffic on the roadway facility.

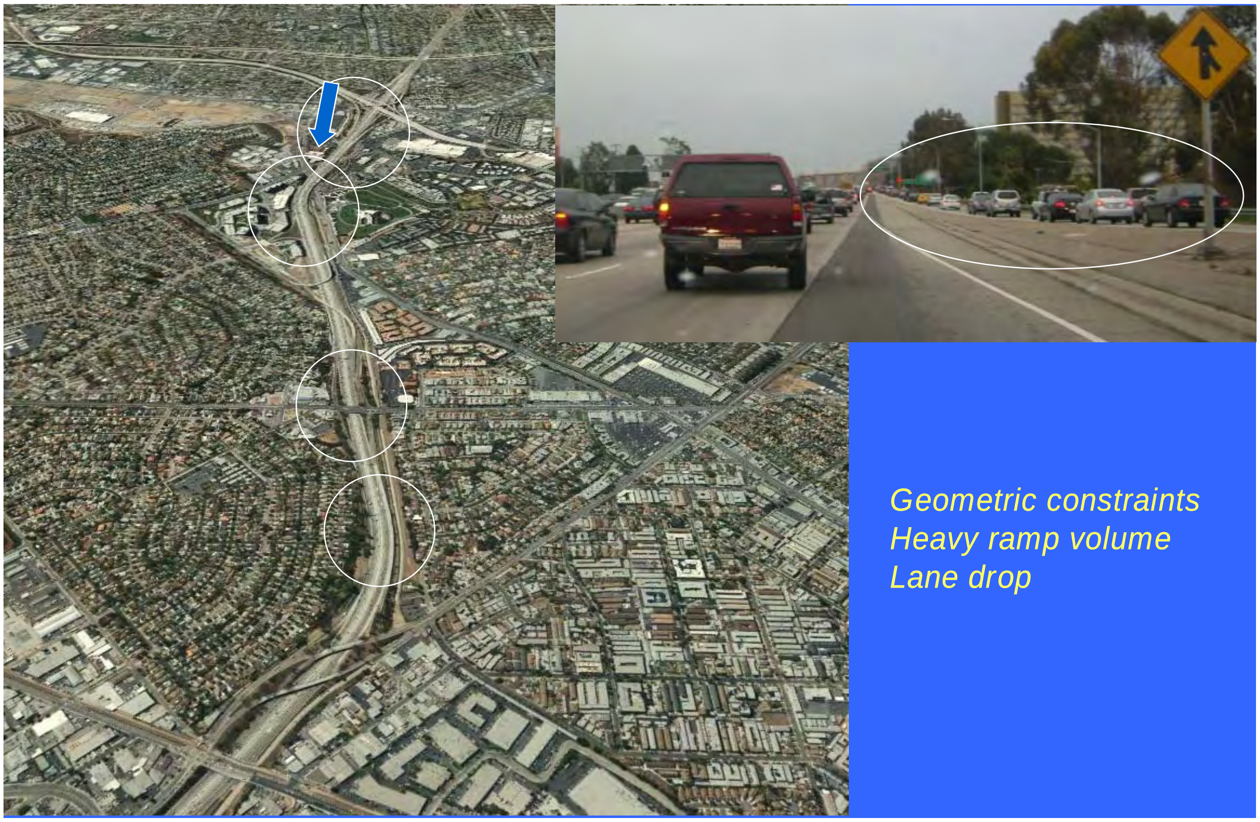
Exhibit 5-11: Southbound I-405 at West Los Angeles (US-101 to SR-90)



La Tijera Boulevard/Howard Hughes Parkway

The primary cause of this bottleneck is the lane drop that occurs at the La Tijera Boulevard off-ramp and the heavy traffic demand from the SR-90 on-ramp. The southbound I-405 mainline traffic demand during the peak hours is very heavy. Add to that the heavy stream of traffic from SR-90 merging with the I-405 traffic, as shown in the Exhibit 5-12 inset photograph, highlighted by the white oval. The connector ramp is not metered. The roadway geometry with the downhill grade and horizontal curves affecting sight distance, particularly at La Tijera Boulevard, contributes to the bottleneck condition.

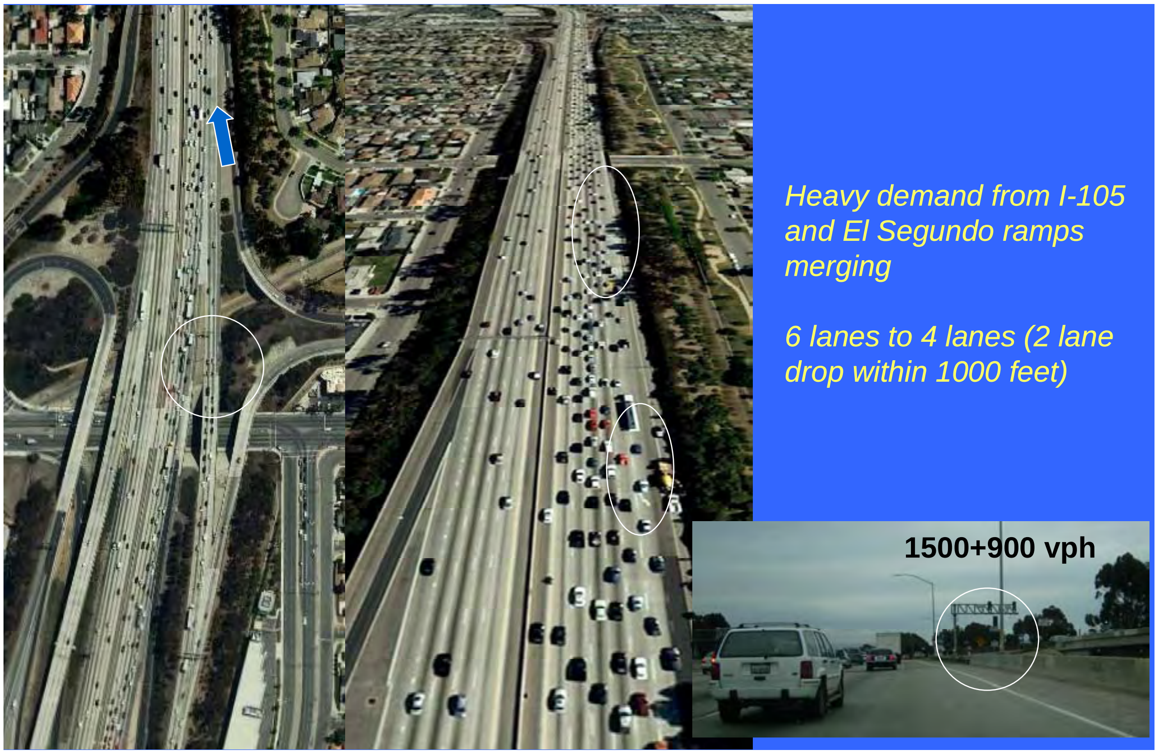
Exhibit 5-12: Southbound I-405 at La Tijera Boulevard/Howard Hughes Parkway



El Segundo Boulevard to Rosecrans Avenue

Exhibit 5-13 shows the aerial photograph of the southbound I-405 mainline at El Segundo Boulevard. As shown, the connector ramp traffic from the I-105 is very heavy, even with ramp metering, at over 1500 vehicles per hour during the PM peak hours. Add to this traffic, the El Segundo Boulevard on-ramp traffic that exceeds 900 vehicles per hour is over 2400 vehicles per hour of traffic merging with the I-405 southbound mainline traffic. The primary cause of the bottleneck is this demand plus the lane drop that occurs downstream, as highlighted by white ovals in the exhibit. The multiple lane drops that occur cause the bottleneck and the severe congestion that follows.

Exhibit 5-13: Southbound I-405 at El Segundo Boulevard/Rosecrans Avenue



Inglewood Avenue/Rosecrans Avenue

As described in the northbound bottleneck at this location, the primary cause of this bottleneck is likely due to the roadway geometry. The large horizontal curve and vertical grade reduces sight distance and affects travel speed, adversely impacting capacity. The analysis of the probe vehicle runs and PeMS speed contours indicates that the bottleneck occurs at the crest of the horizontal curve in both directions as indicated by the blue arrows and outlined by the white circles.

Exhibit 5-14: Southbound I-405 at Inglewood Avenue/Rosecrans Avenue

Crenshaw Boulevard and I-110 Interchange

At the Crenshaw Boulevard interchange, the on-ramp traffic merging onto the southbound mainline traffic is likely to cause the bottleneck at this location. During the PM peak hours, the on-ramp volume exceeds 600 vehicles per hour. The ramp is currently metered.

Much like the US-101 approach, the lane drop from 4 lanes to 3 lanes at the I-110 split, causes the bottleneck and congestion to occur regularly during the weekday PM peak hours at this location. As traffic speeds begin to pickup after the split and bottleneck, another bottleneck is created from the merge of the I-110 traffic and Figuroa Boulevard traffic in three consecutive on-ramps and multiple lane drops. The I-110 connector ramps are not metered. Exhibit 5-15 illustrates this location.

Exhibit 5-15: Southbound I-405 approaching I-110